Delaware · Coastal Zone Management Program

COASTAL FISHERIES ASSISTANCE
PROGRAM

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COASTAL ZONE MANAGEMENT

DIVISION OF FISH AND WILDLIFE

D N R E C

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EXECUTIVE SUMMARY

The Coastal Fisheries Assistance Program, conducted by the Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, with support through a Coastal Zone Management Program Development Grant, Office of Coastal Zone Management, U.S. Department of Commerce, and in cooperation with the Delaware Office of Management, Budget and Planning has completed its first year's objectives by reviewing, identifying and ranking the problems, issues and opportunities related to marine fisheries in Delaware.

A thorough review of the literature and interviews with both commercial and recreational fishermen resulted in historical reviews of fourteen species of finfish and shellfish which have had a significant impact on the socio-economic aspects of the fishing industry in Delaware. These species afforded the most opportunity for commercial and/or recreational interests and consequently the most management problems. The present condition of each fishery is discussed with the overall socio-economic impact of Delaware's fisheries shifting to recreational fisheries. However, the recent enactment of the Fishery Conservation and Management Act of 1976 will definitely provide new issues and opportunities for the commercial fishery industry.

In reviewing the histories of individual fish species, noticeable shifts in their catches are attributable to management, but not in all cases. The oyster industry has dwindled to a remnant of a once dominant shell fishery as a result of improper management. The blue crab fishing industry fluctuates as a result of environmental stress. Weakfish are currently the state's most valued recreational and commercial finfish while the much prized striped bass has declined in numbers at an alarming rate.

Onshore seafood processing has decreased from a time when the menhaden processing plant in Lewes provided Delaware with a 4.6 million dollar industry to virtually a no-value fishery in Delaware when the plant closed in 1968. Surf clam and oysters are the only seafoods presently being processed in commercial quantities in Delaware.

An issue identified with high priority and in need of immediate attention is for the State of Delaware to initiate a coordinated effort to encourage fishery ports and other related industries to locate in Lewes, Delaware. Coincidental to this issue is the need for appropriate legislation to provide the DNREC with regulating authority to manage the taking and landing of marine fisheries within its jurisdiction. Fisheries management must be based on the best available data which many times becomes available at times when decisions for managing a fishery cannot wait for appropriate legislative action. Flexibility must be part of the regulatory process to take advantage of opportunities within various fisheries.

Fishery management of marine species is relatively new and the public must be kept informed and allowed to participate in these management procedures. Public participation through hearings following preparation of reports on proposed fishery managment plans, legislation, and regulations should be strongly encouraged. Legislators, governmental officials, and consumer interest groups should be routinely informed of fishery issues through a specific information and educational program for marine fisheries management. At present, no such program exists and the establishment of one could only be benficial to fisheries management.

Since marine fisheries should be managed and appropriate and equitable allocations of different fish stocks might have to be

made to both recreational and commercial fishermen, catch and effort data on different fisheries will be required. These data will enable a baseline of information to be formulated upon which fishery management decisions will be recommended. Presently there are insufficient data to deal with the problem of marine fisheries management in managing different stocks for separate fishery interests. This is a regional problem and could best be approached by the adoption of appropriate legislation to permit the state to require catch and effort data reporting from fishermen.

While addressing the problem of a data base on marine fisheries, a determination must be made as to what characteristics separate a commercial fishermen from a recreational fishermen. Until this is accomplished, managing the two fisheries will remain an arbitrary and very controversial procedure.

A concurrent problem with the need for a data base on each fishery, are fish stocks assessments. In order to equitable allocate fish stocks between commercial and recreational interests, fish species in question must be adequately understood in terms of their basic biology, population structure and maximum sustainable yield. Again, this is a regional fishery problem and it could best be approached via state and federal cooperative effort.

Another major issue, but not of the least importance, is the need for an enforcement program closely integrated with the above mentioned information and education program regarding new concepts and regulations that will affect the public as a result of marine fisheries management. Integrated is a key word since many of the present enforcement personnel are more than adequately trained in boating safety and first aid but inadequately trained in fishery management issues when public sentiment is aroused.

All of the above issues, problems and opportunities will

require adequately funding. The issues of catch and effort data, collecting, stock assessments, information educational programs and enforcement of marine fisheries management relations could possibly become self-sustaining with appropriate licensing of both recreational and commercial fishermen. These licensing issues should be thoroughly evaluated both on a state basis and/or regional basis in order to complete a totally integrated and efficient marine fisheries program.

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INTRODUCTION

The primary purpose of this year's Coastal Fisheries Assistance Program (CFAP) was to identify problems, issues and opportunities associated with Delaware's coastal fishery resources. This report includes a compilation of information on 14 species of marine fish and shellfish that are valuable to commercial and/or recreational interests in Delaware. Most of these species are, or have been, relatively abundant in Delaware waters, and consequently most resource management problems are likely to be associated with these species. Analyses were made of commercial and recreational fisheries conflicts and socio-economic value of various fisheries. Support for this effort has been provided by the U. S. Department of Commerce, Office of Coastal Zone Management in cooperation with the Delaware Office of Management, Budget and Planning (OMBP).

HISTORICAL SIGNIFICANCE OF FISHERIES IN DELAWARE

The identification of Delaware's fishery problems, issues, and opportunities must first deal with the historical significance of both commercial and recreational fisheries in Delaware. Archeological evidence indicates that American Indians inhabited the shores of Delaware rivers and bays long before the arrival of the first white settlers. The fish and shellfish resources of the Delaware area could have been abundant beyond belief. The migrant Indians learned to catch and also preserve the flesh of fish and shellfish. Indians made ornaments, jewelry, utensils and wampum from fish teeth, bones, molluscan and crustacean shells. The Indians were also among the first of the Delaware settlers to use fish for fertilizer. Commercial utilization of Delaware's natural fishery resources began when Delaware Indians began to trade dried oyster meats, dried and smoked fish, and fish bone and shell ornaments to inland Indian tribes (Horn, 1957).

Nearly all the early written historical accounts of the Delaware region make some mention of the abundance of fish and shellfish. In 1631, Henry Hudson found "numerous islands abounding in good oysters" in what is now known as Broadkill River (Miller, 1962). Many historical references of the 1660's mention the abundance of shad along with William Penn's preference for "smoked shad from the Delaware". It was also reported that during colonial days in Delaware, fish were so plentiful that travelers stepped upon herring and sheepshead splashing in fords and streams, and shad were speared with pointed sticks and sturgeon were lassoed (Horn, 1957).

Delaware's oldest fin fishery was based on the commercial harvesting of the American shad. Shad were commercially landed initially by Indians and later by early colonists. Extensive commercial shad fishing in the Delaware region began during the early 1800's. Shad were abundant and an inexpensive source of protein for the inhabitants of developing towns and cities. Initially, shad were sold for only a few cents each, and the fish rapidly became a staple item in the diet of coastal town and city dwellers. The demand for shad increased as more new towns and cities developed. Shad were sold in hundreds of fish markets and shops and also by the many fish peddlers who sold fish from door to door.

Sturgeon were also fished commercially and extensively along the Delaware Coast and in the Delaware Bay and River from 1850 until the late 1930's. Sturgeon were considered a nuisance by the shad fishermen in 1875, who often killed and cast adrift sturgeon that became entangled in their shad nets (Horn, 1957). Eventually, Delaware commercial fishermen began to realize the value of sturgeon meat, and more importantly, the value of caviar obtained from the roe of the female sturgeon.

Commercial fishermen used large mesh nets to catch sturgeon, and it was not uncommon for a two-man sturgeon boat to fish for several hours and return with 20 or more sturgeon weighing from 150-400 pounds each. Sturgeon were sold for fifty cents or one dollar each, and a 160 pound keg of caviar sold for six to eight dollars. In 1936, sturgeon were selling for $300 each, and caviar was sold

for $300 a keg. Bowers Beach was the site of the first Delaware factory built to butcher sturgeon and process (sieve) the fish roe into caviar. Later, the center of the fishery shifted to Delaware City, and it is believed that during various years several hundred persons were regularly involved in sturgeon fishing in Delaware.

Delaware has had no significant sturgeon landings since the late 1930's, and there has been no commercial fishing effort for many years. At the present time, there are probably more sturgeon in the Delaware River and Bay than at any time since the late 1930's.

The menhaden fishery was unquestionably the largest and one of the relatively more recent fin fisheries to develop in Delaware. Menhaden are used primarily for industrial purposes in the United States, and one of the first large menhaden processing plants was built in Lewes, Delaware in 1912. In 1938, the Consolidated Fisheries processing plant in Lewes was the largest menhaden processing facility in the United States. The plant owners had two dozen menhaden steamers and employed more than 600 men. In 1946, Mr. Otis Smith purchased another existing menhaden plant in Lewes, and in 1954 Mr. Smith purchased the Consolidated Fisheries processing facility. Lewes became the largest fish landing port in the United States in 1953 when 390 million pounds of fish were landed. Twenty-five large company-owned menhaden steamers provided fish for the twin processing plants, and the crew members alone amounted to 650 men. Several hundred additional workers were employed in the factories and as support personnel. Menhaden landings in Lewes and all along the

Atlantic Coast began to decline in 1962. In 1963, one of the menhaden processing plants in Lewes was closed, and in 1966 both plants were permanently closed because the local menhaden stocks had been seriously depleted.

Delaware's oldest shellfish fishery was, and still is, based on the commercial harvesting of wild oysters. Indians were known to barter with oysters, and early historical records are full of accounts which mention the abundance of oysters in Delaware (Horn, 1957). Oysters were initially plentiful and like shad, cheap enough to be utilized as a staple food item by the early colonists. In 1799, oysters sold for two shillings per bushel, the same price quoted by William Penn in the 1680's.

The Delaware oyster industry expanded after World War II, and the landed value of oysters in Delaware amounted to 2.7 million dollars in 1954. The entire Delaware oyster industry was destroyed in 1958 by a microscopic oyster disease organism that became known as MSX.

The oyster industry in Delaware was reasonably large until the time when MSX destroyed it. There were several oyster shucking houses, oyster landing facilities, and a fleet of about 15 large oyster dredge boats that were used to plant and harvest oysters. During the 20 years that have elapsed since MSX destroyed the industry, most of the industry support facilities have been abandoned. There are only seven or eight boats remaining in Delaware and approximately the same number of persons still active in the business.

All three of Delaware's large commercial fin fisheries are now history, and it is unlikely that shad, sturgeon, or even menhaden might be the object of intensive commercial fisheries in Delaware in the future. The oyster industry has been partially subsidized by the state government, and the industry will most likely continue to survive. However, the oyster industry that now exists in Delaware is not likely to again become a prominent commercial fishery.

The decline in all four of Delaware's historic commercial fisheries is in part related to a general decline in fishery resources and the various legislative statutes that have been enacted to either encourage or discourage the commercial utilization of the fishery resources. The Delaware legislature at various times passed laws that defined net mesh sizes, fish size limits, seasons, etc. Various finfish laws were drafted in attempts to regulate and manage various fish species, but a large portion of the finfish laws were special interest legislative acts that benefited local or politically oriented individuals within the state. The state legislature clearly omitted designating any state agency as a regulatory authority or an enforcing agency for marine finfish laws. Consequently, commercial finfish laws in Delaware have become confusing, conflicting, and generally ignored.

The history of the early oyster laws and the later shellfish laws were often more specifically special interest legislation. However, in 1943, the Delaware legislature did establish the Delaware Commission of Shellfisheries, the third such commission

to be established. This shellfish commission was given full control and direction of the state shellfish industry which was primarily oysters at that time. The commission was designated to be responsible for the protection of all shellfish within the state.

The shellfish commission consisted of an executive secretary and four other commissioners, all appointed by the governor in office. Two of the five commissioners were required to be directly engaged in the shellfish business in Delaware. While it may have been desirable to have persons on the shellfish commission who knew about shellfish, the commissioners were placed in the position of managing state shellfish resources on which their own private businesses were based. Consequently, Delaware shellfish regulations have historically favored intensive and almost exclusive commercial utilization of the state shellfish resource, often at the expense of this resource.

The Delaware Commission of Shellfisheries was dissolved in 1970, and its responsibilities were transferred to the Division of Fish and Wildlife in the Department of Natural Resources and Environmental Control. Now, the DNREC clearly has the legislative authority to regulate and manage the shellfish resources of the state. The Department has gained considerable experience in effective management of the shellfish resources and has learned to compromise with the political involvement that previously dominated management of the shellfish resources. However, the Department still does not have the legislative authority to manage marine and anadromous finfish

within Delaware waters, and the state legislature has historically demonstrated a pronounced reluctance to designate a marine fin fisheries regulatory authority.

Status of Fish and Shellfish Stocks in Delaware

Fourteen species of fish and shellfish have been identified as currently or historically important to the commercial and/or recreational marine fisheries of Delaware. The recreational fishery for tuna and billfish that occurs from 30 to 100 miles off the Delaware Coast is an important recreational fishery in Delaware, but the status of these species has not been assessed because management or utilization of these stocks is entirely outside the jurisdiction of the state's territorial sea.

Nearly all Delaware's commercial and recreational fin fisheries are now based on the seasonal migration of fish into Delaware waters during the spring and summer months, and the migration of these fish out of Delaware waters during the fall and early winter months. Throughout the history of all the fin fisheries in Delaware, there have been extreme fluctuations in the species composition of the commercial and recreational catches. At various times, winter flounder, scup (porgies), northern kingfish (king whiting), blowfish, cod, and Atlantic croaker have been important in commercial and recreational fishery landings in Delaware. In recent years, nearly all these fish have virtually disappeared from Delaware waters with the notable exception of the croakers that have just recently returned after being essentially absent for a period of nearly 15 years.

The marine finfish resources in Delaware have never been properly managed due to the lack of designated regulatory authority. Commercial fishing licenses have never been required except for the 1974 requirement of a $100 license fee for menhaden steamers fishing in Delaware waters and the 1978 requirement of commercial eel fishing licenses. Delaware watermen have submitted commercial fishery landing data to the fisheries statistics branch of the National Marine Fisheries Service on a voluntary basis. While the accuracy of the voluntarily reported commercial fish catch might be questioned, this landing data at least gives some indication of the relative abundance or lack of fish during each year.

Prior to the early 1950's, there were only a few persons in Delaware who owned boats of any description. There were practically no privately owned power boats, and only a small number of party and charter boats were actively engaged in marine sportfishing activity. Most marine sportfishing was conducted from shores and piers, and more dedicated marine anglers rented rowboats from boat liveries and rowed to fishing grounds near Port Penn, Woodland, Bowers, Slaughter, Broadkill, Lewes, Rehoboth and Bethany Beaches. Outboard motors were rare, undependable and of low horsepower ratings.

In Delaware, the initial surge in increased marine recreational fishing pressure began in the mid 1950's when outboard motor manufacturers began to produce reliable outboard motors that developed 25, 30 and even 40 horsepower. Boat manufacturers began to produce relatively inexpensive fiberglas and aluminum boats. A large portion of the new boat owners in Delaware apparently purchased boats in order

to gain access to the more productive fishing areas in Delaware Bay and the Atlantic Ocean. The numbers of small and large privately owned fishing boats, party and charter boats increased steadily from the mid 1950's through 1968. Recreational boat fishing pressure nearly doubled during the period from 1968 to 1973 (Miller, 1977).

The commercial landings of several coastal fish species has continued to decline as recreational fishing pressure on the species has increased. In recent years, the annual recreational or sport fishing catch of some coastal fish species is estimated to exceed annual commercial landings by six to twelve times.

Delaware's four major marine shellfish resources include two species of molluscs and two species of crustaceans. The oyster and hard clam resources are not migratory, and these resources occur entirely within state waters. The major crustacean resource is the blue crab which does migrate, but nearly all the migration occurs in or near Delaware waters.

Commercial harvesting licenses are required for harvesters of each major shellfish species, and the reporting of catch and effort data has become mandatory. Here again, shellfish landing data have not always been accurate. On more than one occasion, the buyers of hard clams were found guilty of grossly under-reporting hard clam harvesting because a state landing tax of $.15 per thousand clams was assessed the clam buyers and not the clam harvester. In recent years, the recreational fishing effort on hard clams and blue crabs has increased, and effective management of these resources will require additional catch and effort data from recreational shellfishermen.

The major shellfish resources in Delaware have been regulated by and for commercial shellfishing interests for such a long period of time that many commercial shellfishermen feel they have exclusive rights to harvest state shellfish resources. However, these state shellfish resources may have been over-exploited at the expense of the resources.

Reviews of the 14 selected fisheries species will begin with the marine shellfish resources, primarily because they have been more or less regulated for many years, and consequently there is much more local documentary evidence concerning these resident marine resources.

AMERICAN OYSTER (Crassostrea virginica) RESOURCE IN DELAWARE

Archaeological evidence indicates that oysters have existed in Delaware for many millions of years. The fossilized shells of extinct oysters commonly found along the banks of the Chesapeake and Delaware Canal are estimated to be about 80 million years old. More recent fossil oyster shells suggest that the American Oyster (Crassostrea virginica) began to evolve around 50 thousand years ago. The oysters that inhabit Delaware waters at the present time appear to be the same type of oyster that has been naturally abundant in local bays and rivers for the past several hundred years.

Algonquin Indians from west of the Mississippi migrated east into Pennsylvania, Delaware, Maryland and New Jersey. The numerous Indian shell mounds and kitchen middens indicate that oysters were abundant and used for food extensively by the Indians. Indians also dried oyster meats and sometimes stored live oysters in earthen pits similar to outdoor root cellars. Oyster shells were also used to temper pottery. Nearly all early historical records and maps of Delaware refer to islands and extensive banks of oysters throughout Delaware. Oysters were undoubtedly abundant, easily obtained, and cheap enough to be utilized as a staple food item by early colonists.

The oyster dredge was introduced into Delaware Bay around 1800 by New Englanders seeking seed and market oysters to plant on their private oyster beds. On February 12, 1812 Delaware enacted its first shellfish law in an attempt to restrict oystering to vessels owned within the state. Virginia had prohibited dredging in 1811, and Maryland restricted dredging activity in 1820.

Delaware's first shellfish law and subsequent legislative acts restricting the industry were seldom observed because of lack of enforcement. Throughout the history of the fishery, legislative attempts to manage the resource have been thwarted by special interest groups who have managed to obtain exemptions in local areas and sometimes complete repeal of restrictive laws. During the period from 1830 to 1835, acts were passed to prohibit the dumping of refuse in Mispillion Creek, set fines for breaking oyster laws and resisting arrest, harvesting more than five bushels of oysters at certain locations and establishing a closed oyster season in the creeks from May 16 to August 15. In legislative action passed in 1851, oyster dredging was prohibited. In 1871, the Delaware legislature passed a comprehensive series of oyster laws dealing with leasing, dredging, tonging, licensing, taxation, etc. These new laws established a provision for oyster plantations of 15 acres each. Annual plantation rents were $25, and the vessel working the plantation was assessed $3 per ton. Provisions were also made for an oyster watch boat to patrol the waters night and day from March 1 to September 1 in order to protect the oyster plantations. The east line dividing public oyster grounds and the southern leasable plantation grounds was also established. State revenues from oysters amounted to $4,900 in 1872.

Toward the end of the 1870's, seed oysters from Maryland and Virginia were extensively planted in Delaware Bay. During the 1879-80 planting season, 700,000 bushels of Chesapeake seed oysters were planted on Delaware oyster plantations. In 1878 eighty sloops

and schooners were registered to work in Delaware, and in 1880, this number had dropped to 68. In 1891, the natural oyster beds in the creeks were reserved mainly for oyster tongers. In 1905, an act was passed which permitted only sailing vessels to take oysters from the natural oyster beds. In 1909, a commission was created to look after oyster interests. The oyster commission of 1909 was responsible for obtaining the first accurate survey of natural oyster beds in Delaware which was performed by H. F. Moore in 1910. The planted oyster grounds were surveyed by Captain Charles C. Yates who reported that 6,593 acres of Delaware Bay bottom were leased to oyster planters. The Moore survey indicated that the natural oyster beds in Delaware had been exploited and much of the culch (shell) material had been removed by oyster harvesters. Moore recommended the planting of oyster shells and the enforcement of rough cull harvesting laws.

The Delaware oyster industry of the late 1800's was owned and operated mainly by Philadelphians who owned or leased oyster grounds in Delaware and New Jersey. Most of the oysters that were harvested were sold out of state, either in Philadelphia or Baltimore, and later through Maurice River Cove in New Jersey. Many Delaware oyster planters formed partnerships with New Jersey oyster dealers. Prior to 1922, most oysters were shipped to markets in the shell or in hermetically sealed cans. The practice of shucking oysters and shioping fresh shucked oyster meats began in New Jersey and later shifted to Maryland.

The typhoid epidemic in Chicago in 1925 was attributed to consumption of polluted oysters that had been harvested from Chesapeake

Bay. Adverse publicity linking typhoid with polluted oysters destroyed consumer confidence in all oysters. Oyster consumption dropped to nearly zero, and it was almost impossible to sell oysters for several years.

A cooperative shellfish sanitation program consisting of the U. S. Public Health Service, state and local health agencies, and the commercial oyster harvesters and processors was developed in 1927. This program established strict sanitary standards for shellfish growing waters, shellstock shipping and approved shellfish processing methods. The shellfish sanitation program is still in existence, and through the years, the program has done much to restore consumer confidence in purchasing molluscan shellfish. The per capita oyster consumption data available suggest that the oyster industry never fully recovered the extensive oyster market that was lost because of the typhoid epidemic.

In 1930, Governor Buck appointed another oyster commission to study "the statutes and the general condition of the industry". This commission also reported that the natural oyster rocks had been depleted, the best leased oyster grounds were owned and operated by non-residents, and that nearly all Delaware oysters were being sold outside the state. During the depression years, oyster production in Delaware was low because of the lack of sufficient quantities of seed oysters on natural beds and also because of a lack of money to purchase seed oysters from Maryland or Virginia. In 1939, Galtsoff reported 44 oystermen operating ten or eleven oyster schooners in the Delaware oyster industry. In 1939, state revenue from oyster industry in Delaware amounted to $4,450.

In 1942, Delaware oyster planters requested that the U. S. Biological Survey investigate high mortalities in adult seed oyster populations on the natural oyster beds. Oystermen suspected that channel dredging activities were responsible for the unexplained oyster mortalities. In 1943, the legislature established the Delaware Commission of Shellfisheries. In natural oyster bed investigations conducted in 1943, Frey reported that the rough cull law was still not being enforced. Frey also noted that due to the war and the manpower shortage, power dredging had been allowed on the natural oyster beds, and Frey suspected that power dredging was contributing to the depletion of the natural oyster beds. Frey also noted that most of Delaware's seed oysters were sold to New Jersey.

In 1947, oyster growers in Rehoboth Bay requested the U. S. Biological Survey to investigate excessive oyster mortalities in Rehoboth Bay. From 1943 to 1949, the number of oyster shucking houses in Delaware increased from one to six. Extensive oyster mortalities occurred in the natural oyster beds again in 1950, but oyster planters were still able to harvest 425,000 bushels of seed oysters. The natural bed seed oyster catch declined to 100,000 bushels in 1951 and then dropped to 1,500 bushels in 1956 forcing closure of the beds. From 1951 through 1956, Delaware oyster planters made extensive plantings of seed oysters obtained from Virginia. In 1956, the Delaware oyster industry was valued at five million dollars (Miller, 1962). Actually, the highest reported Delaware landings occurred in 1954, when 4.3 million pounds

of oyster meats valued at 2.7 million dollars were recorded. The second highest Delaware landings occurred in 1957 when 4.2 million pounds of oyster meats valued at 2.2 million dollars were recorded. The MSX disease destroyed the industry in Delaware in 1958. In 1959, Delaware in conjunction with New Jersey imposed an embargo on the importation of out-of-state seed oysters. Reported landings of Delaware oysters from 1947 to 1978 are shown in Table 1.

In 1961, seed oysters in the natural oyster beds began to show some signs of resistance to MSX. Succeeding year classes of natural bed seed oysters became more, but not entirely, resistant to MSX. In 1963, the state spent $150,000 for planting and cleaning shells on the natural beds. In 1965, the natural beds were opened to seed harvesting for a short period, but the seed oysters that were planted did not survive well. In 1968, a moderate spatfall occurred in the natural beds, and a short seed oyster harvesting season was allowed in 1970. In 1970, a large spatfall occurred throughout most of the natural beds in Delaware Bay. The recent history of seed oyster harvesting and market oyster harvesting in the Delaware Bay is shown in Table 2.

The Delaware Commission of Shellfisheries was disbanded in 1970, and the responsibilities of the Commission were transferred to the Department of Natural Resources and Environmental Control. The Division of Fish and Wildlife has monitored spatfall in the natural beds since 1970. State shellfisheries biologists have recently announced that spatfall in the natural beds during the summer of 1978 was abundant enough to revitalize the Delaware oyster industry

TABLE 1

COMMERCIAL OYSTER LANDINGS IN DELAWARE

Year	Lbs. of Oyster Meats	Dockside $ Value
1947	4,105,900	1,418,132
1948	2,850,000	1,077,400
1949	2,190,000	865,250
1950	2,141,000	911,800
1951	2,266,000	1,047,660
1952	2,252,300	1,150,925
1953	3,141,300	1,564,642
1954	4,340,000	2,725,520
1955	3,290,400	1,603,700
1956	1,893,600	782,850
1957	4,194,200	2,226,720
1958	2,410,100	1,717,262
1959	295,000	158,785
1960	176,200	119,683
1961	32,900	18,791
1962	80,600	60,488
1963	40,400	25,086
1964	44,700	26,984
1965	34,100	28,000
1966	45,000	37,000
1967	61,000	40,000
1968	43,200	41,376
1969	50,700	38,014
1970	216,000	132,844
1971	315,000	202,500
1972	508,800	413,367
1973	392,800	342,923
1974	175,900	160,725
1975	195,000	226,751
1976	262,300	380,700
1977	127,500	196,190
1978	68,257	97,510

TABLE 2

BUSHELS OF OYSTERS PLANTED AND HARVESTED IN DELAWARE

Year	Bushels of Seed Oysters Planted	Bushels of Market Oysters Harvested	Value of Harvested Oyster Meats Per Pound
1947	650,000	586,557	$ .35
1948	700,000	475,000	.38
1949	835,000	365,000	.40
1950	600,000	356,833	.42
1951	190,000	377,667	46
1952	155,000	300,307	.51
1953	490,000	392,662	.50
1954	520,000	542,500	.63
1955	468,000	411,300	.49
1956	306,000	236,700	.41
1957		676,484	.53
1958		477,248	.71
1959		45,385	.54
1960		26,697	.70
1961		4,301	.57
1962		12,257	.75
1963		6,196	62
1964		6,877	.60
1965		5,052	.82
1966		6,923	.82
1967		8,764	.66
1968		6,636	.96
1969		7,800	.75
1970	18,600	33,231	.62
1971	43,000	45,000	.64
1972	77,975	72,000	.81
1973	41,095	56,114	.87
1974	52,060	32,157	.91
1975	16,625	27,857	1.16
1976	24,425	37,471	1.45
1977	21,725	18,214	1.54
1978	14,280	9,751	1.43

in 1980. Whether or not the Delaware oyster industry will ever regain a portion of its former prominence is questionable for the following reasons. More than 20 years have passed since MSX destroyed the Delaware oyster industry in 1958. Since that time, nearly all the oyster industry support facilities in the state have been abandoned or allowed to disintegrate. New oyster shucking houses would have to be constructed in order to meet upgraded state and federal public health requirements. Waste water and wash water would require extensive and expensive treatment. The part-time seasonal labor (shuckers, casual labor, boat crews, etc.) is no longer available. Oyster boat crew members cannot be obtained in Delaware. During the past nine years, it has been necessary to recruit and hire boat crews from without the state for seed and market oyster harvesting activities in Delaware.

The Delaware oyster fleet of the 1950's was characterized by old, but serviceable, boats. Since that time, many of the oyster boats have been sold or abandoned. Formerly, oyster boat owners could use their boats to harvest oysters for several months during the year. Then, if they were so inclined, they could dredge for clams or crabs for several more months. Since these shellfish have been in short supply recently, dredging activity for these alternative species is not likely to increase in the near future. Recent seed oyster harvesting seasons have been short (15 - 20 days), and the time required to harvest planted oysters has also been short (15 - 20 days). Large portions of the formerly leased oyster

grounds have been abandoned and have reverted to state ownership. The number of persons actively engaged in the oyster industry has dwindled to approximately 12 persons who are generally operating father/son type businesses.

During the past nine years, oyster production in Delaware has more or less consisted of a relaying operation. Marketable and near-marketable size oysters have been dredged from natural beds and planted on leased beds for periods of three to five months. During the fall, and depending upon the condition of the oysters and the oyster market, the planted seed oysters are dredge harvested and marketed to oyster shucking houses.

There is ample documentary evidence that a good portion of the previously existing natural seed oyster beds in Delaware have been carried away by indiscriminate seed and market oyster harvesters. The Delaware oyster industry has always required large volumes of seed oysters annually, and the records show that natural oyster beds were incapable of continuously providing enough seed oysters to satisfy the industry even during the days of sail dredging. During times when Delaware seed oysters were scarce, Delaware planters often obtained inexpensive out-of-state seed oysters that cost them less than $1/bushel planted in Delaware. Now, it is doubtful that a bushel of oyster shells could be purchased out of Delaware or even purchased within the state and planted in Delaware Bay for less than $1/bushel.

Production of oysters on natural oyster beds is sporadic, and the fact that Delaware natural beds have been able to survive more than 70 years of sail dredging pressure is indeed noteworthy. The ability of any natural oyster bed to survive continuous and effective power dredging pressure is questionable. More than 2.75 million bushels of oysters and shells were removed from Delaware natural oyster beds during the period from 1946 to 1950. In 1953, the seed oyster harvest had dropped to only 20,000 bushels, and the natural beds contained no significant amounts of oysters until the spatfall of 1970, a period of more than 25 years. The 1970 set was commercially significant, but no appreciable spatfall occurred again until 1978. Consequently, seed oysters were once again in short supply in 1977 and 1978. If the 1978 set had not occurred, the future for the Delaware oyster industry would be grim. Of paramount importance to the industry and to the resource managers is the two-year survival rate of the spat that set in 1978.

The State of Delaware has more or less subsidized the Delaware oyster industry since the early commercial development of the industry in 1871. Early state regulations favored industrial utilization of oysters, and although the natural oyster resources are technically owned by the state, the oyster industry has traditionally held control of the resource. More recent oyster regulations (1976) which again were written with the consent of the industry, now stipulate that, "All oysters removed from natural oyster beds in Delaware must be deposited in Delaware on shellfish grounds leased from the Department or on public tonging areas.". With the exception

of the one public tonging area (non functional for several years), Delaware oysters can now be marketed only from privately leased oyster grounds.

The state legislature has always been interested in the oyster industry and has attempted to maintain and improve the industry through various legislative acts including the appointment of various commissions, subsidies and special appropriations. It appears that various persons in the Delaware oyster industry have always had powerful support in the state legislature, and the passage of recent legislation gives some indication of the industry's continuing political clout.

Effective management control of the oyster resource will be difficult because the industry has exercised control of the resource for such a long period of time. However, recent biological evidence and updated surveys by professional shellfish biologists should provide the needed safeguards to conserve these resources.

HARD CLAM (*Mercenaria mercenaria*) RESOURCE IN DELAWARE

Lower Bays - Rehoboth and Indian River Bays

Indian River Bay is a typical drowned river estuary, while Rehoboth Bay is classified as a typical bar-built embayment (Karpas, 1978). Prior to the 1920's, the waters of the Indian River and Bay system flowed through the barrier beach to the Atlantic Ocean through several alternative and naturally eroded channels. Severe storms would temporarily close the natural inlet cuts while subsequent storms and increased rainfall in the river drainage system caused the river and bay waters to break through the barrier beach at alternate locations.

The Assawoman Canal, connecting Indian River Bay and Assawoman Bay, was dug in 1889. The purpose of this canal was not for transportation but primarily to drain the wetlands of Baltimore Hundred. The Lewes-Rehoboth Canal, connecting Rehoboth Bay and Indian River Bay with Delaware Bay, was completed in 1913. This canal was constructed primarily for transportation. The construction of both these canals has been blamed for the permanent closing of the Indian River Inlet during the 1920's. During the period when the Indian River Inlet was closed, most of the oysters and clams in the lower bays died, and lower bay waters became fresh enough for the survival of fresh water fish (Horn, 1957).

The present day location of the Indian River Inlet was opened by a violent storm in 1938 and stabilized with bulkheading in 1939. Stabilization of the inlet increased the salinity in the lower bays with a resulting increase in natural populations of oysters, hard clams and soft-shell clams. The soft-shell clams were among the

first marine bivalves to colonize the more saline lower bays. Initially, recolonization of bay bottoms by hard clams occurred in the vicinity of the newly created Indian River Inlet. Subsequently, hard clams became distributed throughout the saline portions of the lower bays while soft-shell clam populations decreased and all but disappeared. No significant soft-shell clam populations have been found during the past 20 years.

The commercial hard clam fishery in the lower bays began around the late 1940's and was subject to the regulatory authority of the Delaware Commission of Shellfisheries. Initially, commercial and recreational clammers were legally allowed to harvest clams from areas that were not leased as oyster bottom. Hand harvesting methods of signing, treading, wading, hand raking, bullraking and hand tonging were, and still are, the only legal methods of commercially harvesting clams in the lower bays. Early illegal use of Shinnacocking (raking clams with a power boat) led to a specific law (1941) prohibiting the harvesting of lower bay clams by any harvesting method involving mechanical power. Commercial clam tongers were permitted to hand tong clams on leased oyster ground only if they obtained permission from the leaseholder.

The Shellfish Commission issued commercial tonging licenses to Delaware residents, only, for a fee of $5 annually. This tonging license enabled the harvester to tong oysters on public beds in creeks and rivers and also tong or rake up to 1,000 clams daily in the lower bays. The licensed tonger could harvest clams during the entire year in the lower bays, but harvesting activities were restricted to daylight hours and prohibited on Sunday.

Hard clams were not abundant throughout the lower bays until five or ten years after the stabilization of the present Indian River Inlet in 1939. In 1947, the marketability of large hard clams increased, but at that time, there was no strong market demand for small clams. The Shellfish Commission was oyster production oriented, and hard clams were considered to be a nuisance on the oyster grounds in the lower bays. As a consequence, there has never been a management plan for the hard clam resource in the lower bays until just recently.

In the hard clam survey of the lower bays performed by the University of Delaware in 1967 (Humphries and Daiber, 1968), the potential clam producing area surveyed in Rehoboth Bay is reported as 9,312 acres and that of Indian River Bay as 9,064 acres. In 1948, no areas in either bay were closed to shellfish harvesting because of, or as a result of, bacteriologic pollution.

Large sections of Rehoboth and Indian River Bay were leased to individuals for oyster production during the mid 1940's. In 1948, Shellfish Commission records show that 3,164 acres, or approximately 34% of Rehoboth Bay, had been leased for oyster production. At the same time, approximately 1,143 acres, or 12% of Indian River Bay, had been leased for oyster production (Miller, 1962). Nearly all the leased oyster grounds were in the deeper offshore portions (6 - 7 feet) of the lower bays.

Recreational clamming has always been permitted in the lower bays. Delaware residents were legally allowed to harvest 100 clams

a day, including Sundays, for personal consumption. It appears that the first commercial clammers worked only part-time. As the marketability of all sizes of clams increased, more of the part-time clammers began to harvest clams continuously throughout the warmer months of the year. As oyster production declined, former oyster producers and some of the more industrious commercial clammers became clam buyers. Clams in the lower bays were, and continue to be sold by the number of clams and not by the bushel measure as is prevalent in some other clam producing states. Generally, clam harvesters sold their entire catch, regardless of size, to clam buyers for a specified price per thousand. Early prices ranged from $10 to $14 per thousand and did not surpass $20 per thousand until after 1960.

Serious problems with oyster production in the lower bays began in the 1950's, and mass oyster mortalities due to MSX began in 1956. No significant oyster production has occurred in the lower bays since 1959. Subsequently, all the leased oyster ground in Rehoboth Bay and nearly all the leased oyster ground in Indian River Bay reverted back to state/public ownership. In the mid 1950's, hundreds of local Delaware residents were supplementing their incomes by wading and raking clams in the more shallow portions of the lower bays. Harvesting pressure from full and part-time commercial and recreational clammers reduced near shore populations of clams. Reported commercial clam landings declined to only 77,000 pounds in 1962. The March 1962 storm did have some influence on the reduced

landings. Fortunately, in 1961 and 1962, a substantial set of juvenile clams occurred throughout the lower bays. No significant clam set has been reported in the lower bays during the last 16 years, and the importance of the 1961-62 clam set will be seen repeatedly in the mid 1960's landings and also in the size distribution of clams collected in 1967 (Humphries and Daiber, 1968) and also in 1976 (Cole, 1976 a,).

In 1965, bull rakes were first used for harvesting clams in the lower bays. Bull rakes enabled commercial clammers to harvest larger areas in the deeper waters, and the reported 1965 clam landings reflect the increased effectiveness of this harvesting method. Since 1965, there has been a fluctuating overall decline in the reported landings of clams from the lower bays. In 1978, reported clam landings amounted to only 46,200 pounds of meats valued at $65,142.

The National Marine Fisheries Service publishes annual fisheries landing statistics. Their information is obtained through the cooperation of state agencies and personal contact with fishermen and fish buyers throughout the United States. Table 3 presents the most accurate record of hard clam landings that has been reported in Delaware during the past 32 years.

Reliable data pertaining to the catch of commercially harvestable natural resources is difficult to obtain. Watermen are naturally reluctant to furnish information to state and/or federal officials who might one day use this information to restrict

TABLE 3

REPORTED COMMERCIAL HARD CLAM LANDINGS IN DELAWARE

(Quantity: Pounds of Meat Weight)
Value: Dollars Paid Harvesters

Year	Hand Harvested Rehoboth Bay & Indian River Bay		Dredge Harvested Public & Private Delaware		Total State Landings	
	Quantity	$Value	Quantity	$Value	Quantity	$Value
1947	9,000	3,000	-	-	9,000	3,000
1948	112,600	44,820	45,000	18,000	157,600	62,820
1949	59,800	18,268	189,000	57,750	248,800	76,018
1950	142,300	41,550	666,000	162,300	808,300	203,850
1951	135,200	38,430	777,000	273,600	912,200	312,030
1952	140,400	41,700	360,100	100,037	500,500	141,737
1953	405,000	227,710	45,000	25,290	450,000	253,000
1954	429,300	214,650	51,600	25,800	480,900	240,450
1955	112,000	42,000	232,000	111,000	444,000	153,000
1956	584,700	190,019	219,000	66,700	803,700	255,719
1957	318,200	101,370	197,000	55,352	515,200	156,722
1958	217,500	74,350	104,900	29,425	322,400	103,775
1959	214,700	80,520	128,500	45,786	343,200	126,306
1960	173,800	75,955	310,500	116,424	484,300	192,379
1961	214,500	93,870	367,700	137,880	582,200	231,750
1962	77,000	33,197	301,100	112,905	378,100	146,102
1963	81,600	33,122	180,500	73,333	262,100	106,455
1964	164,200	81,675	253,800	103,119	418,000	184,794
1965	326,500	169,385	36,900	15,012	363,400	184,397
1966	264,100	140,280	-	-	264,100	140,280
1967	257,500	137,508	40,900	16,624	298,400	154,132
1968	181,500	99,025	57,300	23,293	238,800	122,318
1969	96,900	53,928	38,600	15,994	135,500	69,922
1970	88,700	55,810	-	-	88,700	55,810
1971	112,900	75,400	* -	-	112,900	75,400
1972	89,700	68,987	-	-	89,700	68,987
1973	63,400	53,805	-	-	63,400	53,805
1974	101,000	94,710	-	-	101,000	94,710
1975	34,400	32,000	-	-	34,400	32,000
1976	51,600	53,617	-	-	51,600	53,617
1977	37,900	57,131	-	-	37,900	57,131
1978	46,200	65,147	-	-	46,200	65,147
TOTAL	5,297,900	2,527,792	4,602,400	1,585,624	9,900,300	4,113,416

*Data not available/no landings reported

the activities of the waterman or increase the levy the waterman might pay for the privilege of utilizing a natural resource. Part-time earnings by many individuals are often considered to be supplemental income, and as such, are not always reported for state and federal tax purposes.

In Delaware, when the lower bay hard clam resource was regulated by the Shellfish Commission, commercial clammers were not required to record or report their clam catches. Clam buyers were required to pay a shell tax of .15/thousand clams bought. Generally, Delaware clam buyers under-reported the volume of clams actually bought in order to avoid payment of the state shell tax. Since 1970, the hard clam resource has been regulated by the Division of Fish and Wildlife of the Delaware Department of Natural Resources and Environmental Control (DNREC), and since 1977, licensed commercial clammers have been required to submit a record of their annual clam catch. In 1977, the fee for a commercial clam license was increased to $50 annually, and the daily commercial clam harvest limit was increased from 1,000 to 2,500 clams per day. A $5 non-commercial clam permit enabling clammers to harvest, but not sell, 500 clams per day was made available at the same time. The increase in the commercial clam license fee and the commercial clam harvesting limit was requested by the full time commercial clammers who were attempting to reduce the activity of part-time commercial clammers.

It is readily apparent that no one will ever know the true volume of hard clams that have been removed from the lower bays.

Some appreciation of the number of persons involved in commercial harvesting can be obtained from Table 4, where U. S. and state records of lower bay clam harvesters are depicted. Table 3 data shows that reported clam landings from the lower bays reached a high of 584,700 pounds in 1956 and then declined to landings of only 77,000 pounds in 1962 and 81,600 pounds in 1963. Data from Table 4 shows that according to U. S. Fishery Statistics, the number of regular, casual and total clam harvesters also declined during that period. The total number of clam harvesters, regular and casual, increased significantly in 1965, the year bull rakes were first introduced, and coincidently, the year when the 1961-62 year class of clams had attained a minimal marketable size. The 1961-62 class of clams was responsible for landing increases that began in 1965 and continued to 1971. The relative abundance of the 1961-62 year class was also responsible for the precipitous increase (95%) in the number of casual clam harvesters.

The general tonging licenses issued by the Delaware Commission of Shellfisheries could be used for oystering or clamming. Early fluctuations on the sale of tonging licenses reflect the opening and closing of natural oyster beds in tidal rivers. The clam tonging licenses issued by DNREC since 1975 were strictly for hand methods of harvesting clams. The slight decline in $50 clam licenses in 1978 is not significant but does indicate that sales

TABLE 4

LICENSED CLAM HARVESTERS IN DELAWARE

	Lower Bay Clam Harvesters (U.S. Fishery Statistics)			Lower Bay Commercial Clam Licenses Issued by State Regulatory Authority		
Year	Regular	Casual	Total	$5 License	$50 License	$5 Permit
1947	-	11	11	132	-	-
1948	25	35	60	209	-	-
1949	30	17	47	154	-	-
1950	36	45	81	114	-	-
1951	35	75	110	96	-	-
1952	10	27	37	111	-	-
1953	23	37	60	187	-	-
1954	20	45	65	191	-	-
1955	21	6	27	191	-	-
1956	51	87	138	61	-	-
1957	78	172	250	97	-	-
1958	74	186	260	250	-	-
1959	107	237	344	127	-	-
1960	62	206	268	180	-	-
1961	60	213	273	-	-	-
1962	40	103	203	-	-	-
1963	40	104	144	-	-	-
1964	40	125	165	-	-	-
1965	95	180	275	-	-	-
1966	95	193	288	-	-	-
1967	123	301	424	-	-	-
1968	110	281	391	-	-	-
1969	102	340	442	-	-	-
1970	88	393	481	-	-	-
1971	100	376	476	-	-	-
1972	84	282	366	-	-	-
1973	54	142	201	-	-	-
1974	53	148	201	-	-	-
1975	* -	* -	165	397	-	-
1976	-	-	-	370	-	-
1977	-	-	-	-	69	143
1978	-	-	-	-	66	83

*Data not available

of commercial clamming licenses will probably continue to decrease in 1979. More significant, and more indicative of the decline in the lower bay hard clam population is the 58% decrease in sales of the $5 clam harvesting permit. Apparently, many of the permit holders were unable to harvest much more than 100 clams per day in 1977.

Recreational harvesting of hard clams in the lower bays began in the mid 1940's when hard clams became abundant. Recreational harvesting pressure has increased with recreational development in the area. Recreational clam harvesting limits of 100 clams per day per person were not considered restrictive when clams were abundant. Since the recreational limit also applied to children, entire families went on clamming excursions, often catching 1,000 or more clams without requiring a license. The recreational clammers have never been required or requested to submit catch records to state officials much to the chagrin of the commercial clammers who are now required to furnish this information.

The volume of clams harvested recreationally is not known. There seems to be little doubt that substantial numbers of Delaware residents and visitors participate in recreational clamming. In a survey of marine recreational fishing in Delaware performed in 1976 (Miller, 1977), 78,407 man days of recreational clamming was reported for the lower bays during the period April 1 through October 31, 1976. Recreational clamming pressure may have slightly decreased recently along with the decreasing availability of near shore and smaller size clams.

There has been a surprisingly large number of scientific studies performed in the lower bays. Some of the earlier biological studies were reviewed in 1969 by Daiber. More recently, Jensen (1976) reviewed the scientific data that had been published and prepared an annotated bibliography of the scientific literature available at that time. Only two scientific surveys of the hard clam population in the lower bays have been performed.

The first shellfish survey of the lower bays was performed by the University of Delaware during the summer of 1967 and reported in 1968 (Humphries and Daiber, 1968). The sampling stations were established in Indian River Bay and Rehoboth Bay along a true north-south, 500-yard grid system. Standard oyster tongs were used to make two grabs of the bay bottom covering an area of five square feet at 393 stations throughout the bays. The Humphries and Daiber sampling method consisting of standard oyster tongs was not efficient in collecting clams that were buried deeper than three or four inches in the bay bottom, and oyster tongs were not effective in catching clams smaller than 1½ inches. Analysis of Humphries' data shows that 320 clams, three scallops, no oysters (not surprising), and one surf clam were collected from a total of 393 stations of five square feet each. Humphries did not collect any clams at 238 stations. All the clams collected in the Humphries survey were measured and assigned to one of the eight commercial size categories. Humphries found that clams in the commercial size of eights and thousands, ranging in size from 2½ to 3½ inches (6.4 to 8.9 cm.), were most abundant

and accounted for approximately 65% of the estimated standing crop. Humphries gave standing crop estimates of approximately 116,894 bushels (935,152 pounds) for Indian River Bay and 103,827 bushels (519,135 pounds) for Rehoboth Bay.

During the period from August 1975 to August 1976, a similar survey was performed (Cole, 1976 a.) by DNREC. Cole sampled the lower bays on a magnetic north-south, 500-yard grid system. Involving 338 stations, Cole used divers equipped with a hand-held Venturi suction dredge. The divers used the suction dredge to remove all the clams and sediment inside a one square meter frame to a depth of one foot. Sediments and all clams larger than 3/8 inch were retained for analysis. The diver-Venturi dredge bottom sampling method is considered to be the most accurate method available for sampling infaunal benthic organisms. Analysis of Cole's date indicates that 947 clams were collected from the total 338 sampling stations of one square meter each. Cole did not collect any clams at 92 sampling stations. Cole's square meter sampling areas were more than twice the size of the five square foot areas sampled by Humphries and Daiber. Considering the thoroughness of Cole's collecting method, Cole should have been able to collect considerably more clams than Humphries and Daiber if the abundance of clams had remained relatively stable.

Cole also measured all clams for length frequency distribution, and he found that approximately 65% of the clams he collected ranged in size from about 3-1/8 inches to 4-5/16 inches (8 - 11 cm.). Lacking local clam growth data, Cole utilized growth data from Massachusetts

and surmised that the predominant size (6.4 - 8.9 cm.) clams collected in the 1967 survey by Humphries and Daiber had increased in size (8 - 11 cm.) by 1975-76 but were still the most abundant size clams from which the bulk of the entire clam population was composed. There appears to be little doubt that the dominant size clams collected by Humphries and Daiber in 1967 and the dominant but slightly larger size clams collected by Cole in 1975-76 were survivors of the massive natural clam set that occurred in 1961-62. Cole found few clams less than 2 cm. in size. Clams that set naturally in the lower bays appear to require a minimum of three growing years before attaining the minimal legal harvesting size of 1½ inches (3.8 cm.). The lack of significant numbers of sub-legal clams as evidenced by Cole's survey, clearly indicates that clam populations will continue to decrease through 1979 and most likely well into the 1980's.

Nearly all the ten states that harvest hard clams along the Atlantic Coast of the United States report low level recruitment of juvenile clams in areas that are harvested regularly. High level recruitment appears to occur only occasionally and is sometimes sufficient to sustain a sizeable commercial and recreational clam fishery for a number of years (Ritchie, 1976).

In the lower bays, low level recruitment should not be attributed to lack of adequate brood stocks. Sizeable brood stocks exist in areas that are closed to harvesting for public health reasons. Even in areas that are harvested regularly, harvesting

pressure is selective in that both commercial and recreational harvesters seek clams of the more desirable smaller size. Recreational clammers can only utilize a small number of the large chowder size clams, and many are not interested in harvesting any of the larger size clams. Commercial clam harvesters also try to avoid harvesting the larger size clams because clam buyers do not ordinarily like to buy large clams. Clam buyers are now paying clam catchers around $.11 each for small clams (cherrystones and little necks) and only $.05 each for chowder size clams.

Poor recruitment is generally attributed to environmental conditions that adversely affect the successful spawning and subsequent survival and growth of larval and juvenile clams. Recent hydrographic data (Karpas, 1978) and flushing rates for Indian River Bay and Rehoboth Bay indicate that planktonic clam larva should have ample time to set in the lower bays before being lost through Indian River Inlet.

Low level clam recruitment is not likely to be due to increased predation because the population size of several known hard clam predators has been reduced. Blowfish, or puffer fish, (Spheroides maculatus), known predators of small hard clams, have been absent from the lower bays since 1973. Whelks, or conchs (Busycon sp.), are now caught commercially by traps and dredges outside the Inlet. Blue crabs (Callinectes sapidus) are recreationally caught in commercial type crab pots throughout the lower bays to a degree that approaches directed commercial effort. Even the lowly horseshoe crab (Limulus sp.), a suspected juvenile hard clam

predator, is now collected (females only) for baiting eel pots throughout the lower bays and tributary creeks and rivers.

Hatchery techniques for the production of large volumes of juvenile hard clams are well established (Loosanoff and Davis, 1963), but juvenile clams must be protected from predation and dislocation for one or more years. Economically feasible methods of protecting juvenile hard clams have been reported (Castagna, 1970), and juvenile clam planting experiments have been conducted in Rehoboth Bay.

The first seed clam planting experiments were conducted by the University of Delaware in 1972-73 (Keck, 1973). Keck used crushed sea clam shell as aggregate to protect small (1 - 3 mm.) seed clams and obtained a survival rate of 47% during the first year. However, in subsequent planting experiments of more than 1,000,000 small clams, survival ranged from one to fifteen percent.

The most recent clam planting experiments were also conducted in Rehoboth Bay in 1976 by DNREC (Cole, 1976 b.). Cole conducted planting experiments in sub-tidal water similar to the experiments conducted by the University of Delaware. Cole reported a one year survival rate of less than one percent. Cole was unable to continuously monitor the experiment due to the water depth.

Although clam mariculture attempts have been unsuccessful thus far, these clam planting experiments should be repeated in several intertidal areas. Although ideally suited intertidal areas are not abundant in the lower bays, there are a number of areas where clam planting experiments could and should be conducted.

In summary, there appears to be substantial evidence that the hard clam population in the lower bays (Indian River Bay and Rehoboth Bay) has been reduced significantly. Evidence is seen in reduction of reported commercial clam meat landings and also in the number of harvesters involved in the commercial clam harvest. Perhaps, one of the better indicators of clam stock depletion is the increased price that clam harvesters are receiving for their clams. There are only a few shallow water areas in the lower bays where clam mariculture efforts might be successful.

Natural resource management requires the following five basic types of information:

1. Reliable information regarding the relative abundance of the resource.
2. The rate of resource renewal by growth.
3. The rate of resource renewal by reproduction.
4. The rate of resource removal by natural causes.
5. The rate of resource removal by commercial and recreational harvesting.

It can be seen that most of the basic information is not available at the present time, and some of the information on harvesting might never be obtained. The commendable hard clam survey that was conducted in 1975-76 clearly should have been repeated annually in order to obtain continuing reliable data regarding resource availability. The relative abundance of clams in wild populations fluctuates naturally, and although the causes for population fluctuations are unknown, it is unlikely that the causes can be

controlled even though they might be suspected (McHugh and MacMillan, 1976). The clam populations in the lower bays are approaching what might be the lowest recorded level of abundance. Increased harvesting pressure, or any improvement in harvesting efficiency or effectiveness can only cause a more rapid decrease in the resource.

The regulatory agency must assume a stronger role in effective management of the resource, initially by obtaining more factual information about the resource and also by the continuation and expansion of experimental clam mariculture. Utilization of hard clam resources has been controlled mainly by hard clam buyers and harvesters who have used their influence to pass legislation pertaining to hard clam harvesting. Existing clam regulations should be re-evaluated for the benefit of the resource.

In evaluating the validity of the few remaining leased oyster grounds in Indian River Bay, resource management officials should seriously consider the fact that the lower bays have produced only a few insignificant volumes of oysters during the past 20 years, and it is highly unlikely that any production of oysters will occur in the foreseeable future. Seed oysters will continue to be scarce and/or too expensive to plant in large quantities in areas where recreational boating pressure is increasing and the bacteriological content of the water is likely to increase.

Although the near shore clam populations have been decreased by commercial and recreational harvesting, the deeper portions of both bays still contain reasonably heavy concentrations of large chowder size clams and commercial quantities of small clams in a few areas.

Hard Clams in Delaware Bay

During pre-colonial times, American Indians harvested hard clams along the shores of Delaware Bay. The clam meats were utilized as food, and the clam shells were used to make jewelry and wampum. Early Delaware colonists (Miller, 1962) also gathered clams from the more shallow portions of Delaware Bay. More recently, inter-tidal populations of hard clams existing at the mouth of the Mispillion and the Murderkill Rivers were reported (Horn, 1957). In 1959, schematic maps of subtidal commercial hard clam grounds in Delaware Bay and short discussion of the commercial clam fishery were published (Shuster, 1959).

A survey of the hard clam resource in Delaware Bay was conducted by the University of Delaware in 1971-1972 (Keck, 1974), and the decline and virtual cessation of the Delaware Bay commercial clam fishery was reported by Cole (Cole, 1976 c.).

Poultry and meat shortages during and immediately after World War II led to the increased development and unprecendented production of clam products. Initially, the clam meat processors preferred to utilize the meats of the larger chowder size clams. A record total United States landing of 21.5 million pounds of hard clam meats occurred in 1947. Total U. S. hard clam meat landings gradually declined to around 15 million pounds in 1954, and total hard clam meat landings have averaged around 15 million pounds for the past 24 years (Ritchie, 1976). Large scale utilization of hard clams from Delaware Bay began in the late 1940's when the marketability of large volumes of clam meats occurred. Recent increases in the landed value of hard clams may enable the lower bays to support a limited commercial fishery for several more years.

Prior to World War II, the Delaware oyster dredge fleet was composed of sail-powered vessels. During and after the war, the sail-powered vessels were converted to gas and diesel-powered dredge boats. Apparently, in the late 1940's, hard clams were relatively abundant in natural clam beds as well as on leased and vacant oyster grounds throughout Delaware Bay.

Oyster dredge boat captains developed a heavier type oyster dredge with longer teeth for harvesting hard clams in the bay. The size of the clams that were harvested was generally large, and nearly all the commercial clam catch was sold to the Campbell Soup Company.

The highest recorded Delaware Bay hard clam harvest occurred in 1951 when 777,000 pounds of clam meats with a dockside value of $273,600 were landed. If the standard conversion factor of eight pounds of clam meats per U. S. Standard Bushel is used, the volume of the record 1951 dredge catch would have amounted to 97,125 Standard U. S. bushels of clams valued at approximately $2.82/bu. In 1953, clam meat landings had declined to 330,000 pounds, and in 1967 Delaware Bay landings amounted to only 40,900 pounds.

The commercial hard clam dredge fishery ceased to operate around 1966-67, when existing wild clam stocks became depleted. Ironically, Delaware Bay dredge clammers were only receiving about $3/bu. when Campbell Soup Company (the only buyer) began using surf clam meats for chowder processing. Hard clams that are harvested from Delaware Bay are not usually as valuable as the clams harvested from the lower bays,as shown in Table 5.

TABLE 5

COMPARATIVE PER POUND VALUE OF CLAM MEATS

Year	Rehoboth Bay & Indian River Bay	Public & Private Delaware Bay
1947	$ .33	-
1948	.40	$ .40
1949	.31	.30
1950	.29	.24
1951	.28	.35
1952	.30	.28
1953	.56	.56
1954	.50	.50
1955	.37	.48
1956	.32	.30
1957	.32	.28
1958	.34	.28
1959	.37	.36
1960	.44	.37
1961	.44	.37
1962	.43	.37
1963	.41	.41
1964	.50	.41
1965	.52	.41
1966	.53	-
1967	.53	.41
1968	.54	.41
1969	.56	.41
1970	.63	-
1971	.67	-
1972	.77	-
1973	.85	-
1974	.94	-
1975	.93	-
1976	1.04	-
1977	1.51	-
1978	1.41	-

Keck (1974) reported the collection of only 1,270 hard clams with a total of 336 clam collecting dredge tows. Keck did not collect any clams in 216 of the 336 dredge tows. Furthermore, 375 Petersen Grab samples (0.1 meter area) yielded only ten juvenile clams. Keck did report commercial quantities of hard clams around Old Bear Shoal and Joe Flogger Shoal. Some Delaware watermen speculate that Keck's survey did not locate several areas of high clam concentration throughout the bay. If significant hard clam populations had existed in Delaware Bay, the boats that regularly dredge for oysters, crabs, conchs, mussels, or clams would most likely have found larger numbers of hard clams.

In summary, it appears that the waters, and quite possibly the bottom of Delaware Bay, are not suited for appreciable natural production of hard clams at the present time. Years ago, environmental conditions might have been more conducive to the survival and growth of hard clams in Delaware Bay. The clams that were harvested from 1949 through 1964 were basically old clams and long-time survivors of year classes that could have occurred 15 or even 30 years ago.

BLUE CRAB (*Callinectes sapidus*) RESOURCE IN DELAWARE

Blue crabs evolved in shallow and temperate estuarine areas along the eastern and Gulf Coast of the United States. Blue crabs developed during the lower Miocene period (more than ten million years ago). Even today, significant populations of blue crabs exist only in areas from which they appear to have evolved.

The geographic range of the blue crab is along the East Coast of the United States from Cape Cod to Mexico. Blue crabs have been found as far north as Nova Scotia and as far south as Uraguay. They have been introduced into European waters where they have survived, but they have not been found to be abundant except within their historically geographic range in the waters of the United States.

Apparently, blue crabs are able to tolerate only the temperature extremes that occur within their normal geographic range. Mature hibernating blue crabs in Delaware Bay are often killed when bottom temperatures reach critical levels associated with ice coverage during severe winters, but mature and juvenile crabs in shallow bays and rivers are seldom killed by winter ice cover. In a similar manner, blue crabs are sometimes killed by prolonged exposure to critically warm water. Delaware and New Jersey are the northernmost states in which blue crabs occur in commercial quantities. Self-sustaining blue crab populations do not occur in cold waters north of New Jersey or in warm waters south of Texas.

The blue crab fishery is the largest crab fishery in the United States. In terms of both commercial and recreational value,

blue crabs are one of Delaware's most valuable shellfish resources. In 1976, commercial crabbers in Delaware landed 3,650,300 pounds of crabs, valued at $1,155,013. In 1977, the commercial crab catch amounted to only 880,400 pounds, a reduction of more than 75% of the previous year's total. The commercial volume and value of Delaware blue crab landings are shown in Table 6. Recreational crab catch data is difficult to obtain in Delaware as well as many other states.

The volume of crabs caught commercially or recreationally during any year is dependent upon the relative abundance of crabs. The lack of crabs has been the subject of much speculation and many scientific investigations. Blue crab scientists agree that the relative survival of a year class of progeny is the most important factor contributing to the abundance of crabs one year later. There are many complex environmental factors and some harvesting factors that can exert a profound influence on the survival of various year classes of crabs.

The recreational catch of crabs at Woodland Beach and other locations along the shores of Delaware rivers and bays indicates that blue crabs were quite abundant in the state prior to the expansion of the commercial fishery in 1947. Early commercial harvesting methods consisted almost entirely of baited trotlines and dip nets. During World War II, the sail-powered oyster dredge boats were allowed to install motors for power dredging. In 1947, many of these vessels began to dredge for crabs during the winter months. The crab pots or traps that now constitute the only warm water method of crab

TABLE 6

COMMERCIAL BLUE CRAB LANDINGS IN DELAWARE

	Hard Crabs		Soft Crabs & Peelers		Total	
Year	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
1947	1,248,300	150,000	3,000	1,000	1,251,300	151,000
1948	1,459,000	152,950	8,700	2,700	1,467,700	155,650
1949	2,233,000	207,350	57,600	18,912	2,290,600	226,262
1950	4,411,600	215,240	9,500	3,025	4,421,100	218,265
1951	4,646,000	328,710	6,500	2,008	4,652,500	330,718
1952	1,250,000	142,350	4,400	1,100	1,254,400	143,450
1953	1,728,000	223,000	2,000	2,000	1,730,000	225,000
1954	2,912,000	253,000	3,000	2,000	2,915,000	255,000
1955	2,811,000	249,000	8,000	4,000	2,819,000	253,000
1956	3,578,000	422,000	2,000	2,000	3,580,000	424,000
1957	4,922,000	416,000	1,000	1,000	4,923,000	417,000
1958	2,454,000	186,000	1,000	(1)	2,455,000	186,000
1959	1,650,000	156,000	-0-	-0-	1,650,000	156,000
1960	2,109,000	220,000	40,000	11,000	2,149,000	231,000
1961	759,000	52,000	54,000	15,000	813,000	67,000
1962	1,884,000	119,000	26,000	9,000	1,910,000	128,000
1963	522,000	34,000	3,000	1,000	525,000	35,000
1964	313,000	32,000	2,000	1,000	315,000	33,000
1965	546,000	43,000	12,000	4,000	558,000	47,000
1966	571,000	49,000	(1)	(1)	571,000	49,000
1967	288,000	34,000	-0-	-0-	288,000	34,000
1968	223,400	39,745	-0-	-0-	223,400	39,745
1969	509,700	62,072	2,600	1,651	512,300	63,723
1970	608,200	106,802	1,800	1,102	610,000	107,905
1971	1,013,800	202,890	9,200	5,292	1,023,000	208,182
1972	2,552,000	671,700	10,500	7,560	2,562,500	679,260
1973	2,373,400	653,550	17,700	12,690	2,391,100	666,240
1974	2,247,700	401,541	72,600	52,245	2,320,300	453,786
1975	3,550,800	782,988	33,800	24,367	3,584,600	807,355
1976	3,565,100	1,075,093	85,200	79,920	3,650,300	1,155,013
1977	862,200	301,700	18,200	38,500	880,400	340,200
1978	333,504	145,042	12,144	30,388	345,048	175,430

harvesting in Delaware Bay were introduced in 1948. In Delaware waters, crab pots soon proved to be far superior to the older trotline harvesting methods, and by 1960 trotline methods of harvesting were obsolete. The relative proportion of crabs commercially harvested by various harvesting methods is shown in Table 7.

Throughout the years, commercial crabbers in Delaware have landed significant quantities of crabs, but the dockside value of Delaware crabs has been low until just recently. There have been various explanations for the previous and generally consistent low dollar value for crabs harvested in Delaware. The principal argument has been that Maryland and Virginia dominate the regional crab market and that crab processing firms within these states purchase Delaware crabs only when their own local supplies are scarce. It is true that Delaware does not have, and apparently has never had, any processors of blue crabs.

Crabs caught by the winter dredge fishery consist almost entirely of female crabs, and nearly all of these crabs used to be sold to crab processors in other states. Traditionally, the potted crab catch has been purchased by small, independent buyers who in turn sell the Delaware crabs to Philadelphia and New York markets, as well as to restaurants and bars that specialize in serving steamed crabs. Recently, there has been a marked and unprecendented increase in the number of establishments that specialize in serving steamed crabs both seasonally and throughout the year. The recent increase in the landed per-pound value of Delaware blue crabs is shown in Table 8.

TABLE 7

DELAWARE COMMERCIAL BLUE CRAB CATCH BY GEAR
(POUNDS)

Year	Trot Lines	Soft & Peeler Pots & Nets	Hard Crab Pots	Winter Dredged
1947	420,000	3,000	-	828,300
1948	397,000	8,700	162,000	900,000
1949	1,583,000	57,600	504,000	147,000
1950	223,000	9,500	536,900	3,651,700
1951	150,600	6,500	642,300	3,853,100
1952	-	4,400	950,000	300,000
1953	-	2,600	1,300,000	427,500
1954	-	3,400	2,572,500	338,400
1955	60,200	10,500	2,148,600	600,000
1956	35,700	2,300	2,221,200	1,320,800
1957	46,000	1,500	3,164,500	1,711,100
1958	17,600	500	1,260,000	1,176,000
1959	3,700	-	1,113,700	532,600
1960	5,600	40,000	1,561,400	542,200
1961	-	53,700	628,500	130,900
1962	-	25,900	1,675,400	209,100
1963	-	3,400	256,100	266,200
1964	-	2,300	273,000	40,300
1965	-	12,000	545,600	-
1966	-	-	388,600	182,400
1967	-	-	253,600	34,300
1968	-	-	223,400	-
1969	-	2,600	462,000	47,700
1970	-	1,800	608,200	-
1971	-	9,200	1,013,800	-
1972	-	10,500	2,504,000	48,000
1973	-	17,700	2,334,000	39,400
1974	-	72,600	1,906,900	340,800
1975	-	33,800	-	-
1976	-	85,200	-	-
1977	-	18,200	-	-
1978	-	12,144	333,504	-

TABLE 8

LANDED PER POUND VALUE OF DELAWARE BLUE CRABS

Year	Price/Lb.	Year	Price/Lb.	Year	Price/Lb.
1947	$ .12	1958	$ .08	1968	$ .18
1948	.11	1959	.09	1969	.12
1949	.10	1960	.11	1970	.18
1950	.05	1961	.08	1971	.20
1951	.07	1962	.07	1972	.26
1952	.11	1963	.07	1973	.28
1953	.13	1964	.10	1974	.20
1954	.09	1965	.08	1975	.22
1955	.09	1966	09	1976	.32
1956	.12	1967	.12	1977	.39
				1978	.51

The number of persons actively engaged in the commercial crab fishery varies directly in relation to the abundance of crabs, and more recently in relation to the value of crabs. At the present time, and for a number of years now, the blue crab has been the state's most valuable shellfish resource. Since 1971, commercial crab landings have been much more valuable than the landings of oysters, hard clams, or lobsters. The blue crab fishery employs more Delaware residents by far than any other commercial fishery. Delawareans are involved in a number of commercial crabbing activities including, but not limited to, boat captains, crew members, boat hull and motor maintenance, crab pot building, bait catching and crab shedding activities.

More recently, the increased value of Delaware crabs has resulted in a significant increase in the number of fulltime and part-time commercial crabbers. The number of licenses issued for potting and dredging crabs is shown below in Table 9.

TABLE 9

CRAB POT AND CRAB DREDGE LICENSES IN DELAWARE

Date	Crab Pot	Crab Dredge
1970	28	-
1971	25	-
1972	43	-
1973	66	-
1974	77	-
1975	94	17
1976	106	33
1977	79	26
1978	40	-

The 1976 commercial blue crab catch of 3.65 million pounds was the fourth largest volume reported, and the 1.15 million dollar value of the catch was by far the highest value ever reported for crabs landed in Delaware. More units were involved in harvesting crabs in 1976 than in any other year of record. There has been speculation that the blue crab resource is being over harvested. The winter of 1976-77 was severe, and cold water temperatures could have killed a large portion of the over-wintering population of female crabs. Crabs were predictably scarce in 1977 and in 1978. The winters of 1977-78 and 1978-79 were also severe, and consequently many over-wintering female crabs could again have been killed by critically cold temperatures.

Surprisingly, blue crab populations that inhabit the lower bays (Indian River and Rehoboth Bay) do not appear to have been damaged during the record cold winters. The lower bays and all tidal rivers have been reserved for recreational crabbing, and commercial crabbing within these waters is prohibited. Recreational crabbers still crab with hand lines, but many have switched over to the utilization of the more effective crab pots. No one is allowed to use more than two commercial crab pots in order to catch crabs for personal consumption, and they are restricted to harvesting no more than one bushel per day.

Crab Pot Fishery

At the present time, blue crab populations can be harvested with legally sanctioned harvesting methods during eleven and a half

months of the year. Crab potting is an effective method of catching crabs in Delaware Bay, and the crab potting season extends from March 1 through November 30. Landing records show crab pots to be effective in catching "sooks", "peelers", and "jimmies". The crab dredging season extends from December 15 through March 31 of each year. The winter dredge fishery has proved effective in catching "sooks" (mostly fertilized females), and some male crabs. There is some question as to whether a winter crab dredge fishery is desirable or advisable, and there are those who think that expansion of the crab pot fishery should be curtailed. There are questions pertaining to harvesting methods and their impact on the resource.

Winter Dredge Fishery

The winter crab dredge fishery was started by oyster dredge boats that were rigged for dredging. During winters when crabs were abundant, private fishing boats installed temporary dredging equipment and entered the crab dredge fishery. Today, the oyster dredge fleet has been reduced to only a few dredge boats that still form the nucleus of the crab dredging fleet. Several winter crab dredge fishermen are also actively involved in the crab pot fishery during the warmer months of the year.

It has been reported that the winter dredge fishery is justifiable because a certain portion of the bedded female crabs is not likely to emerge from semi-hibernation. It has been argued that a large portion of the bred female crabs will be caught in

the spring by the crab pot fishery. Biologically, it would be almost impossible to prove or disprove that the winter dredge fishery is especially damaging to the resource.

Economically, the crab pot fishery is much more valuable to the state than the winter dredge fishery. More persons are involved in the crab pot fishery, and the per-pound value of potted crabs is higher than the value of crabs dredged during the winter. The Delaware Bay blue crab population has been reduced, possibly by over harvesting and definitely by the damaging effect that three successive severe winters have had on the over-wintering female crab population. In view of the current economic value of the blue crab resource, the winter crab dredge fishery, since it benefits only a few fishermen, should be reevaluated.

During the past ten years, recreational crabbers have increasingly used commercial type crab pots. The number of recreational pots fished in the lower bays might approach the number used in commercial crabbing locations. This type of recreational crab fishing should also be evaluated to insure that crab populations in the lower bays are not over harvested.

AMERICAN LOBSTER (*Homarus americanus*) RESOURCE IN DELAWARE

The geographic range of the American lobster extends from southern Labrador to Cape Hatteras. Within the geographic range, the lobster resource is divided into the northern inshore population and the Mid Atlantic offshore population. American lobsters are also commonly called Maine or northern lobsters. The genus, *Homarus*, evolved to inhabit cool boreal waters of high salinity and rough or rocky sea floors that offer food and protection.

The Delaware Coast generally lacks rocky habitat that lobsters require, and inshore lobster populations exist in Delaware only within the confines of man-made habitats such as stone breakwaters and remains of shipwrecks. Apparently, lobsters were attracted to the breakwater in Lewes soon after it was constructed in the late 1800's. An account of the oyster industry in 1902 states that with the formation of the breakwater, lobsters and black fish (tautog) came there in quantity. Early landing information suggests that the lobster populations inhabiting the breakwaters in Lewes have fluctuated. The commercial catches that have been reported have ranged from a high of 39,000 pounds to less than 1,000 pounds. The commercial lobster fishery in Lewes was closed from the early 1950's until the late 1960's, when it was reopened. Recent commercial lobster landings are shown in Table 10. In 1976, lobster fishing regulations were revised, and a $50 fee for a lobster fishing license is now required.

TABLE 10

COMMERCIAL LOBSTER LANDINGS FOR DELAWARE

Year	Pounds	Dollars
1969	-	-
1970	-	-
1971	30,000	$41,250
1972	22,000	36,500
1973	29,500	51,400
1974	26,300	54,675
1975	27,300	48,800
1076	26,200	55,310
1977	18,200	38,500
1978	30,800	70,340

	Inshore Landings		Offshore Landings	
Year	Pounds	Dollars	Pounds	Dollars
1971	30,000	$41,250	-	-
1972	22,000	36,500	-	-
1973	28,000	49,000	1,500	$ 2,400
1974	15,000	33,750	11,300	20,925
1975	-	-	-	-
1976	-	-	-	-
1977	-	-	-	-
1978	5,000	-	25,800	-

Although suitable natural lobster habitat does not exist along the nearshore Delaware coastline, such habitat does exist in offshore waters along the Canyon edges in water depths ranging from 50 to 100 fathoms. A few lobsters have always been taken incidentally in the commercial potting of sea bass within the 20 fathom line. In 1973, one Delaware boat entered the offshore lobster fishery. In 1978, two boats were potting lobsters offshore and landing their catches at Indian River. During 1978, the inshore Delaware lobster fishery consisted of five licensed fishermen who fished out of Lewes, Delaware. Total reported inshore catch was estimated to weigh approximately 5,000 pounds.

Lobstering inshore in Delaware is basically limited to the outer breakwaters at Lewes. Fishing effort will most likely continue to increase and decrease in direct relation to the catchability of the lobsters within this relatively small area. Lobster fishery regulations initiated in 1976 are basically sound and should be continued. The size of the inshore resource is quite small, and the small commercial fishery is part-time and almost casual. Existing regulations provide for a two-pot-per-person recreational fishery which has not yet been utilized to any great extent. The offshore fishery is conducted from 20 to 70 miles offshore and entirely outside Delaware's current jurisdiction. The offshore resource is probably being over fished at the present time.

WEAKFISH (*Cynoscion regalis*) RESOURCE IN DELAWARE

Weakfish in Delaware are more commonly called trout or sea trout. These fish are normally inhabitants of Delaware's bays and coastal waters only during the warmer months of the year (April to October). Weakfish inhabit Atlantic coastal waters from Massachusetts to southern Florida, but the major population center extends from Rhode Island to North Carolina. Delaware Bay might be one of the major weakfish spawning areas along the Mid Atlantic Coast. Weakfish have been the predominant fish caught by Delaware Bay recreational fishermen for a number of years (Lesser, 1968; Martin, 1973). In a 1976 survey of marine recreational fishing in Delaware, weakfish accounted for 40 percent of the entire sportfish catch, and weakfish were ranked as the state's most important marine recreational fish (Miller, 1977).

Weakfish may well be the most valuable state marine resource at the present time. In the 1975 national survey of hunting and fishing, it was estimated that marine anglers in Delaware spent approximately 25 million dollars annually. It is conservatively estimated that approximately 50 percent of the total recreational marine fishing activity in Delaware is directed toward weakfish. Therefore, recreational fishing for weakfish in Delaware could have a value in excess of 12 million dollars at the present time.

Weakfish have not always been abundant in Delaware waters, and the exceptionally large fish that have been caught in and

near Delaware Bay during the past seven years are definitely larger and much more abundant than any previous records indicate. During the mid 1940's and until 1972, the trout population in Delaware Bay and surrounding waters was composed mainly of young fish ranging in age from one to four years and generally ranging in size from one-half to two and one-half pounds. Three-pound fish were rarely caught by commercial or recreational fishermen. In 1969, the minimum qualifying weight for weakfish in Delaware's sportfishing tournament was three pounds, and only one trout qualified that year.

Extensive commercial trout landings were made by haul seines, fyke nets and gill net fishermen immediately after World War II. The small fleet of trawlers that operated within Delaware Bay from 1942 to 1966 relied heavily on trout landings, and the trawlers were largely responsible for record commercial trout landings that occurred in 1949 and 1955 through 1957 (Table 11). As Delaware Bay trout became relatively less abundant during the period 1960 to 1971, haul seines and fyke nets became obsolete, and commercial trout fishermen began to rely almost entirely on staked or drifted gill nets. Commercial netting of trout in Delaware usually occurs in early spring before trout can be caught by hook and line fishermen. The commercial value of trout usually drops soon after recreational fishermen begin to catch large quantities of trout. Commercial net fishermen claim that recreational fishermen depress commercial fish values when they sell recreationally caught surplus fish to restaurants and fish buyers.

TABLE 11

COMMERCIAL WEAKFISH LANDINGS IN DELAWARE

Year	Pounds	$ Value	Average Price/Pound
1947	582,100	35,549	.06
1948	639,300	51,168	.08
1949	1,038,000	29,835	.03
1950	573,400	58,100	.10
1951	666,200	71,839	.11
1952	281,100	20,388	.07
1953	732,000	50,000	.07
1954	369,000	62,000	.17
1955	1,579,000	123,000	.08
1956	958,000	57,000	.06
1957	1,282,000	71,000	.06
1958	325,000	33,000	.10
1959	182,000	21,000	.12
1960	8,000	1,000	.13
1961	134,000	24,000	.18
1962	143,000	16,000	.11
1963	148,000	17,000	.11
1964	127,000	14,000	.11
1965	221,000	21,000	.10
1966	90,000	9,000	.10
1967	8,000	1,000	.13
1968	4,500	517	.11
1969	21,300	3,102	.15
1970	147,100	30,986	.21
1971	212,900	41,121	.19
1972	406,300	42,766	.11
1973	334,000	84,070	.25
1974	280,900	64,049	.23
1975	289,800	66,367	.23
1976	246,000	63,053	.26
1977	332,000	70,332	.21
1978	299,400	67,694	.23

Prior to 1972, the so-called tide runners that were occasionally caught by recreational fishermen at night seldom weighed more than four pounds. This size trout was also occasionally caught in commercial nets.

Trout populations in Delaware remained at relatively low levels during most of the 1960's and did not show any significant increase in numbers until 1971. The first indication of a dramatic increase in the number of large trout returning to Delaware Bay occurred in 1972, when four and five-pound trout suddenly began to appear in gill nets. Recreational fishermen were able to catch these larger trout on artificial lures several weeks earlier than they normally catch the smaller size trout. In 1972, the state awarded 971 citations for trout weighing three or more pounds. Apparently, several successful trout spawning years occurred during the late 1960's and early 1970's because many of the trout returning to Delaware Bay after 1972 returned as much larger fish. The number and size of large weakfish in Delaware increased after 1972 to such an extent that it became necessary to increase the minimum citation qualifying weight to 3.5 pounds in 1973, seven pounds in 1974, and ten pounds in 1976.

Trout that are spawned in Delaware Bay during the late spring spend their larval and juvenile lives in upper Delaware Bay and lower Delaware River. Large numbers of these tiny trout are sometimes trapped on screens covering cooling water intakes for refineries and power plants. In investigations performed by the

Delaware Division of Fish and Wildlife, it was found that thousands of trout, spot, menhaden and perch juveniles were trapped daily on cooling water screens at the Getty Refinery near Delaware City. Similar investigations of the cooling waters at the Salem Nuclear Power Plant disclosed that 0.5 million juvenile weakfish were entrapped daily during most of July 1978 (Public Service Electric and Gas Company, 1978).

Trout juveniles and also adult trout leave Delaware estuaries during the late fall and migrate south and offshore to over-winter somewhere off the Carolina Coast. The nine or ten-inch trout that return to Delaware are sexually mature and about one year old. The reproductive capacity of weakfish appears to increase significantly when fish attain weights of four or more pounds. The 1978 year class of weakfish spawned in Delaware Bay might be the largest reproductive year class that has ever been recorded.

Existing, but currently unenforced, weakfish regulations require that haul seine meshes not be less than two inches and gill net meshes not less than two and three-quarter inches. The minimal legal weakfish size in Delaware is ten inches total length. Present day gill net fishermen have expressed a desire to be licensed and a willingness to identify their fishing gear. They also have expressed a strong desire to prohibit recreational fishermen from selling their surplus catches.

In the summer of 1976, large schools of trout were found in the Atlantic Ocean outside Delaware Bay and from five to eleven miles off the Delaware Coast. Increasing numbers of party, charter and private recreational fishing boats fished for these large trout outside Delaware's three-mile territorial sea.

BLUEFISH (Pomatomus saltatrix) RESOURCE IN DELAWARE

The bluefish is an inhabitant of inshore and offshore waters along the Atlantic Coast from Nova Scotia to Uruguay. Bluefish have been unusually abundant in the mid Atlantic region for a long time, and the average size of the fish within the population also appears to have increased. Mature fish spawn at the surface of offshore waters during April and May in the area from North Carolina to Florida. In the mid Atlantic region, from Cape Hatteras to Cape Code, spawning occurs from June through August (Wilk, 1977).

In the spring, large bluefish schools migrate northward into Delaware Bay and nearby Atlantic Ocean waters during the month of May. The fish remain in or near Delaware waters until late fall when they migrate southward to offshore over-wintering areas somewhere off the coast of Florida. There are no directed commercial net or commercial handline fisheries for bluefish in Delaware, although such fisheries do exist in the coastal states from North Carolina to New York. The landed value of bluefish in Delaware has averaged around ten cents per pound, and the sale of recreationally caught bluefish throughout the summer months keeps prices down and gluts the market. The reported commercial bluefish landings in Table 12 are actually incidental fish that are landed by commercial net fishermen attempting to catch more valuable fish such as trout or striped bass.

The size of the bluefish stocks along the mid Atlantic coast of the United States has fluctuated widely throughout the history of the fishery. Historical records indicate that bluefish

TABLE 12

COMMERCIAL BLUEFISH LANDINGS IN DELAWARE

Year	Pounds	$ Value	Avg. Price/Lb.
1968	400	72	.18
1969	-0-	-0-	-0-
1970	-0-	-0-	-0-
1971	-0-	-0-	-0-
1972	600	90	.15
1973	2,700	410	.15
1974	5,900	990	.17
1975	15,000	2,202	.15
1976	11,700	1,920	.16
1977	32,100	3,231	.10
1978	40,400	5,552	.14

populations tend to gradually increase over a period of years and rapidly decrease to lower levels for a number of years. The present day bluefish stocks appear to be larger, and the size of some of the fish within the population is definitely larger than has ever been recorded in the past. Persons who have seen the bluefish come and go state that bluefish have remained abundant for a longer period of time than ever before. Although bluefish do not now have, and apparently have never had, a particularly high market value to the commercial fishery, more recreational fishermen actively fish for bluefish than for any other fish along the mid Atlantic coast. More boats are chartered for bluefishing and more private boats, surf and jetty fishermen regularly fish more often for bluefish than for any other fish.

In lower Delaware, and especially Indian River Inlet, bluefish have been the most reliable fish during the past ten years for charter boats. Bluefish can usually be caught when other fish refuse to bite. In sharp contrast to the low commercial value of bluefish (around $.10/lb.) recreational fishermen hold bluefish in high esteem, and it is estimated that the recreational value of bluefish in Delaware is more than $1/lb.

SUMMER FLOUNDER (*Paralichthys dentatus*) RESOURCE IN DELAWARE

The normal range of the summer flounder, or fluke, extends from New England to northern Florida. Summer flounder reside in shallow coastal and high salinity estuarine waters during the warm months of the year, and most fish migrate to offshore water depths of 20 to 100 fathoms during the colder winter months. Spawning occurs during the fall and winter as the coastal fish populations are moving to offshore over-wintering grounds (Bigelow and Schroeder, 1953; Poole, 1966). Summer flounder in Delaware normally begin to enter high salinity bays and rivers during the early spring (April - May).

Summer flounder were caught in commercial quantities by the small fleet of trawlers that fished within Delaware Bay from the early 1940's until the mid 1960's. Substantial commercial landings were made during some years as shown in Table 13. Almost all the significant commercial flounder landings were made by the trawling fleet which ceased after 1966. More recently, in the spring and sometimes in the fall, a few summer flounder are caught incidentally in gill nets that have been set for shad, weakfish, croaker or striped bass. Summer flounder were not abundant in Delaware Bay during the late 1960's and early 1970's, but incidental commercial landings began to increase in 1975 when the recreational summer flounder catch also began to improve.

Nearly all the mid Atlantic commercial flounder catch is landed by coastal trawl fishing vessels that fish for flounder that

TABLE 13

COMMERCIAL LANDINGS OF SUMMER FLOUNDER IN DELAWARE

Year	Pounds	$ Value
1947	46,300	7,935
1948	15,000	3,000
1949	8,300	1,245
1950	24,600	3,485
1951	19,800	3,120
1952	69,200	10,730
1953	53,000	11,000
1954	21,000	3,000
1955	26,000	3,000
1956	60,000	9,000
1957	48,000	7,000
1958	209,000	28,000
1959	95,000	13,000
1960	44,000	5,000
1961	76,000	11,000
1962	24,000	4,000
1963	17,000	3,000
1964	16,000	4,000
1965	25,000	6,000
1966	13,000	3,000
1967	-0-	-0-
1968	-0-	-0-
1969	-0-	-0-
1970	-0-	-0-
1971	-0-	-0-
1972	-0-	-0-
1973	100	18
1974	-0-	-0-
1975	4,700	1,320
1976	3,300	990
1977	4,500	2,111
1978	500	205

are over-wintering in deep water offshore. The coastal trawlers follow the flounder that migrate to inshore areas during the warmer months and again offshore during the late fall. The inshore and shallow coastal bay recreational flounder fishery is no less intensive, and in 1974, summer flounder were ranked as the third most frequently caught marine fish in the mid Atlantic area (McHugh and Ginter, 1978).

The value of the mid Atlantic coastal stock of summer flounder has long been recognized by state and federal resource managers. Summer flounder are now being studied under a state/federal program in order to develop a resource management plan that can be implemented by the states in their territorial seas. The state/federal program will have to develop some method of controlling offshore flounder trawling in order to enable effective management of the entire Atlantic summer flounder stock.

The summer flounder resource in Delaware is now utilized almost entirely by recreational hook and line fishermen because trawl fishing is not allowed in Delaware Bay or within three miles of the Delaware Coast. The summer flounder that migrate back into Delaware waters during the early spring are caught incidentally by gill net fishermen. The recreational catch of summer flounder in Delaware Bay has been increasing during the past several years. In a marine recreational fish survey conducted in 1976 (Miller, 1977), summer flounder accounted for almost eleven percent of the recreational fish catch. Summer flounder were ranked third after weakfish (40%)

and croaker (20%) in the recreational fish catch. Summer flounder that are caught in Delaware Bay are usually caught incidentally by fishermen who are using squid strip bait or lures to catch weakfish, but direct flounder fishing effort might increase in the future.

In Delaware and southward along the Delmarva Peninsula, summer flounder are caught more frequently in the vicinity of ocean inlets and within shallow coastal bays. Live top minnows (killifish) or fresh frozen shiners (Menidia) are the most popular and often the most successful baits used to catch summer flounder in shallow water. A sizeable recreational flounder fishery exists in Indian River Bay and near the Indian River Inlet.

BLACK SEA BASS (*Centropristis striata*) RESOURCE IN DELAWARE

The range of the black sea bass extends along the Atlantic Coast from Florida to the Gulf of Maine (Miller, 1959). The species appears to be most abundant during the summer in nearshore rough bottom areas between New York and North Carolina (Hildebrand and Schroeder, 1928). During the warmer months of the year (March to November), sea bass inhabit rough bottom areas, wrecks and rock jetties in the Atlantic Ocean and also in the lower portions of Delaware Bay. In lower Delaware Bay and in the Atlantic Ocean off the Delaware Coast, sea bass are highly sought after by party and charter boats. Sea bass are one of the few marine fish that can be caught by hook and line fishermen throughout most of the fishing season (April - October). Sea bass are also caught commercially in bass pots which are set offshore along the coast of Delaware in water depths of around 80 feet. A small, but effective, commercial bass pot fishery is operated by one sea bass boat out of Indian River.

In autumn, sea bass migrate offshore in a southerly direction to water depths of around 73 to 165 meters (Musick and Mercer, 1977) where they over-winter. Adults and young migrate inshore and northward in the spring where they seek out rough bottom areas for food and protection. Spawning occurs from May through October, presumably in high salinity waters since no eggs or larva have been collected in estuarine waters.

Party and charter fishing boats that fish out of Indian River Inlet rely heavily on sea bass fishing parties for a large portion of their business. During the post World War II years until 1969, large catches of sea bass (300 - 500 fish) could be made on the old bass grounds. The bass grounds are a large rough bottom area located off Indian River Inlet where water depths range from 60 to 90 feet. Party and charter boats usually drifted over the rough bottom and were able to make good catches of sea bass, along with fair catches of red hake (Urophycis chuss) which is locally called ling or ling cod.

Around 1969, hook and line catches of sea bass and ling began to decline on the bass grounds. Many of the more experienced fishing boat captains resorted to fishing for sea bass around wrecks and snags. Some of the more experienced boat captains speculated that the large bluefish had eaten or chased the sea bass and ling away.

Delaware party and charter boat catches of sea bass probably reached one of the lowest levels during the summer of 1978 when sea bass were extremely difficult to find. In the spring of 1979, water temperatures stayed cool for a longer period than usual, and the size and numbers of the sea bass catch showed some improvement, but only for a short period of time.

Sea bass are caught commercially in bass pots from New York to Virginia. Bass pots are usually set around underwater obstructions or on rough and uneven bottom in water depths ranging from 30 to 100 feet. Sea bass show a definite affinity for inhabiting underwater

obstructions. Bass pots are not baited, and the sea bass presumably enter bass pots while searching for protective habitat. Normally, 20 large bass pots are attached to one pot buoy which carries a flag and often a number. Pots are periodically hauled at weekly intervals, emptied of their contents, and set again throughout the warmer months of the year.

Since sea bass can only be caught in commercial quantities by the pot fishery, the value of sea bass has been high and will most likely continue to be high. The landed value of sea bass is now around one dollar per pound. At the present time, Delaware has only one bass pot fishing boat, but New Jersey and Maryland bass boats have been potting sea bass off the Delaware Coast for many years. Recent commercial sea bass landings in Delaware are shown in Table 14.

TABLE 14

COMMERCIAL SEA BASS LANDINGS IN DELAWARE

Year	Pounds	Value	Price/Lb.
1971	30,000	$ 9,300	.31
1972	40,000	13,200	.33
1973	80,000	18,080	.23
1974	80,000	22,880	.29
1975	180,000	46,800	.26
1976	150,000	45,000	.30
1977	220,000	52,800	.24
1978	160,000	64,000	.40

ATLANTIC CROAKER (*Micropogon undulatus*) RESOURCE IN DELAWARE

Atlantic croakers range from Massachusetts to Argentina (Dahlburg, 1975). Spawning occurs in the Atlantic Ocean from October through February, and larvae and young fish enter estuarine areas during late fall and winter. Severe winters supposedly kill young fish that are over-wintering in the tidal rivers of Virginia (McHugh and Ginter, 1978). In the mid Atlantic region, adult croakers over-winter south of Cape Hatteras and migrate northward along the shore during the early spring. During the past several years, adult size croakers did not arrive in Delaware waters until midsummer, although a few large fish were taken in nets throughout the early spring and summer. In late fall, croakers congregate along ocean beaches and begin a southward migration generally following the shoreline.

During World War II, significant populations of Atlantic croakers inhabited Delaware waters during the warmer months of the year. Large fish, weighing up to five pounds, were caught off Rehoboth Beach, Delaware and along most of Delaware's Atlantic coastline. Smaller fish of one or more pounds were caught throughout most of the lower portions of Delaware Bay. In Delaware, croaker landings by commercial and recreational fishermen rapidly declined during the postwar years until 1958 when croakers mysteriously disappeared from Delaware waters for approximately 15 years.

No one knows why the croakers left Delaware waters or why these fish started to return to Delaware in 1975. During the late 1940's and early 1950's, croakers accounted for a significant portion

of the total recreational fish catch in Delaware. The highest commercial landings of croakers occurred in 1955 when 667,000 pounds were reported. Croakers are not even mentioned in recreational fishing surveys reported by Lesser (1968) and Martin (1973). Croakers were rarely seen in exploratory fish surveys performed by the University of Delaware Marine Laboratories from 1961 until after 1974.

Croaker and nearly all the coastal migratory finfish are subject to periods of cyclic abundance. The abundance, or lack of abundance of most fish and shellfish is closely related to the relative survival of each year class of progeny. Croaker may be even more susceptible to extreme estuarine environmental factors because the young-of-the-year croaker over-winter in estuarine areas. The progeny of other coastal migratory fish including weakfish, bluefish, shad, and others utilize estuarine areas as nursery grounds during the summer, but nearly all juvenile and adult fish leave the estuaries during the fall.

In 1974, a few small croakers began to appear in recreational fish catches within Delaware Bay and in the nearby Atlantic Ocean. In 1975, the recreational croaker catch increased, and there was even a small commercial landing of croakers (Table 15). Suddenly, in 1976, croakers accounted for 20 percent of the recreational fish catch. The 1976 marine recreational fishing survey (Miller, 1977) showed that weakfish accounted for approximately 40 percent of the Delaware marine recreational fish catch, but croakers were ranked as the second most frequently caught recreational fish. The

TABLE 15

COMMERCIAL CROAKER LANDINGS IN DELAWARE

Year	Pounds	$ Value
1947	7,200	840
1948	32,300	3,230
1949	88,000	11,400
1950	6,100	1,040
1951	4,900	783
1952	8,300	1,238
1953	43,000	5,000
1954	60,000	4,000
1955	667,000	44,000
1956	27,000	2,000
1957	167,000	19,000
1958	3,000	(1)
1959	9,000	1,000
1960	(1)	(1)
1961	-0-	-0-
1962	-0-	-0-
1963	-0-	-0-
1964	-0-	-0-
1965	-0-	-0-
1966	-0-	-0-
1967	-0-	-0-
1968	-0-	-0-
1969	-0-	-0-
1970	-0-	-0-
1971	-0-	-0-
1972	-0-	-0-
1973	-0-	-0-
1974	-0-	-0-
1975	1,300	317
1976	2,600	832
1977	8,900	1,841
1978	7,300	1,934

recreational croaker catch was again high in 1977, along with commercial croaker landings, but both recreational and commercial landings showed a significant decrease in 1978. All the substantial commercial croaker landings in Delaware occurred before 1957, when trawl nets and haul seines were still being used in Delaware waters. All the commercial landings after 1975 were made by gill net fishermen.

STRIPED BASS (*Morone saxatilis*) RESOURCE IN DELAWARE

Striped bass normally inhabit marine and estuarine coastal waters from the St. Lawrence River in Canada to the St. Johns River in northern Florida. The range of the striped bass also extends along the Gulf Coast from western Florida to Louisiana (Raney, 1952). Striped bass were successfully shipped by rail and introduced into California during the late 1800's, and now the striped bass range extends along the West Coast from southern California to the Columbia River. Striped bass have become landlocked in fresh water impoundments, and striped bass have been successfully introduced into some fresh water lakes and ponds. Along the Atlantic Coast, striped bass have been most abundant from Cape Cod to North Carolina. The tributaries of the Chesapeake Bay have long been recognized as the major spawning grounds for the species and the major population center. From Delaware southward, striped bass are commonly called "rock" or "rockfish".

Some male striped bass become sexually mature when they are two years old, and nearly all male fish are sexually mature at the age of three. Female striped bass start to become sexually mature at the age of four, and nearly all female fish are sexually mature when they are six years old. Spawning occurs in fresh and oligohaline (less than 3.0 ppt salinity) water during late April and early May when temperatures reach 15°C. Eggs hatch in 36 to 48 hours at 15 - 17°C. (Mansueti, 1958), and larva and young fish utilize shallow waters as nursery areas. Young and adult fish over-winter in the deeper portions of the larger estuaries.

Since 1947, striped bass have been sporadically abundant in Delaware, but they have always been highly valued by commercial and recreational fishermen within the state. The annual commercial landings of striped bass (Table 16) give a reasonably good indication of their relative abundance in Delaware. Significant portions of the commercial landings from 1947 until 1966 were made by the fleet of small trawlers that operated within Delaware Bay. Trawl fishing within Delaware Bay and within three miles of the ocean coast became illegal in 1967. The landing data show that commercial striped bass landings in Delaware have seldom been substantial except for the immediate post World War II years and the 1972 - 1975 period.

Recreational striped bass fishing in Delaware has not been good for a number of years, and now fair recreational catches occur only during the occasional years when commercial net landings have also been significant. During recent years, nearly all striped bass landings in Delaware appear to result from fish migrating into Delaware waters. At the present time, there do not appear to be any large resident populations of striped bass in Delaware waters, although years ago (de Sylva, 1962) it was reported that the Delaware River supported a racially distinct population of striped bass.

Many years ago, the Delaware River was one of the major spawning rivers for striped bass. Water pollution and low dissolved oxygen levels prevented striped bass from utilizing traditional spawning areas in the Delaware River, and the major spawning area shifted to

TABLE 16

COMMERCIAL STRIPED BASS LANDINGS IN DELAWARE

Year	Pounds	$ Value	Average Price/Lb.
1947	109,000	28,000	.26
1948	361,000	90,000	.25
1949	255,000	68,000	.27
1950	271,000	65,000	.24
1951	215,000	53,000	.25
1952	120,000	32,000	.27
1953	106,000	34,000	.32
1954	146,000	25,000	.17
1955	88,000	24,000	.27
1956	28,000	7,000	.25
1957	16,000	4,000	.25
1958	22,000	5,000	.23
1959	12,000	3,000	.25
1960	25,000	5,000	.20
1961	66,000	12,000	.18
1962	108,000	11,000	.10
1963	48,000	9,000	.19
1964	31,000	6,000	.19
1965	32,000	4,000	.13
1966	64,000	13.000	.20
1967	66,000	12,000	.18
1968	48,700	10,000	.21
1969	41,700	8,042	.20
1970	54,100	11,778	.22
1971	38,800	8,978	.23
1972	248,300	67,457	.27
1973	580,100	166,249	.27
1974	212,400	65,136	.31
1975	106,000	43,213	.41
1976	80,600	56,069	.70
1977	57,100	41,412	.73
1978	37,600	37,457	1.00

the Chesapeake and Delaware Canal. The C. & D. Canal is now considered to be one of the major spawning areas for striped bass. Net flow in the C. & D. Canal is toward the Delaware River, and consequently the lower Delaware River and Bay should be an important nursery ground for striped bass. However, juvenile striped bass have not been particularly abundant in Delaware waters since the early 1970's.

All striped bass populations experience substantial fluctuations in year class strength. Successful spawning and reasonably good survival of a year class of fish can influence commercial and recreational landings for a number of years. The most recent dominant year class of striped bass was produced in 1970. These fish attained a minimal harvestable size in 1972. Increased commercial landings from 1972 through 1975 were due to the relative abundance of fish that were spawned in 1970. Unfortunately, there have been no dominant year classes of striped bass produced in the Chesapeake area since 1970, and resident striped bass populations have fallen to critically low levels. The reproductive potential of the major striped bass population center located within the Chesapeake Bay has been seriously reduced by continuous commercial and recreational fishing pressure in combination with the lack of significant reproductive success since 1970.

The relatively low population levels of striped bass in the Chesapeake system and the enactment of emergency commercial harvesting restrictions in Chesapeake Bay has caused the landed value of striped bass to climb to unprecendented levels. In early 1979, commercial fishermen were receiving as much as $2.50 per pound for striped bass.

The landed value of striped bass in Delaware is currently higher than the landed value of any finfish that is commercially harvested. Some indication of the current scarcity of striped bass can be seen in Table 16, where the landed value of striped bass has significantly increased while landing volumes decreased.

Years ago, striped bass appeared to reside in the Delaware River, Delaware Bay and many of Delaware's tidal rivers, including the Indian River-Rehoboth Bay system and the Nanticoke River system which drains into Chesapeake Bay. In the early spring (March-April) large schools of two and three-year old fish would sometimes migrate northward along the Atlantic Coast and into Delaware bays and rivers. Some of these migrating fish might have spawned in Delaware waters, but most of the fish appeared to stay in Delaware only for a short time before continuing a northward migration up the New Jersey Coast to New York and beyond. In the fall, a similar southward migration occurred when striped bass again briefly returned to Delaware waters. The Delaware netting season for striped bass extends from November through April 30, and the minimum gill net mesh size is two and three-quarters inches while the minimum haul seine mesh size is two inches. The minimum legal fish size is twelve inches, fork length, and the maximum size is 20 pounds in Delaware Bay, only, which supposedly protects females. This maximum size does not apply to fish caught in the Atlantic Ocean, seaside bays, or the Nanticoke River and tributaries.

The recreational (sportfishing) catch of striped bass in Delaware has fluctuated widely along with commercial landings.

Recreational fishermen can catch "rock" with bait and lures along the ocean beaches, Indian River Inlet, lower Delaware Bay, lower Delaware River and along the Chesapeake and Delaware Canal. Striped bass have been caught only occasionally by recreational fishermen in the central portion of Delaware Bay. Throughout the state in recent years, rock fishing is only good when migrating striped bass are entering Delaware waters during the early spring or late fall.

Marine resource management officials in the mid Atlantic region have been instrumental in establishing a state/federal program in order to develop a management plan for striped bass resources along the East Coast. A private citizens committee of concerned individuals has recommended that striped bass fishermen in Delaware voluntarily observe and adhere to the following:

> "In order to conserve existing stocks of striped bass, a species that has been on the decline for several years, the Regional and Delaware Citizens Advisory Committees on striped bass management request that you voluntarily limit your catches according to the following guidelines:
>
> Sport Fishing (Hook and Line)
>
> Atlantic Ocean
>
> A minimum size limit of 26 inches total length (tip of snout to tip of tail) on all striped bass (rockfish) taken in Atlantic Ocean waters including the Indian River Inlet. A bag limit of four (4) striped bass per person per day is recommended in this same zone.
>
> Spawning and Nursery Areas
>
> The Delaware River and Delaware Bay, the C&D Canal, all Delaware tidal tributaries, and the Nanticoke River and Broad Creek are considered spawning and/or nursery areas. It is recommended that a size limit of 14 inches total length and eight (8) striped bass per day be observed in spawning and/or nursery areas.
>
> Commercial Fishing (Nets, etc.)
>
> It is recommended that a 14" size limit be observed by commercial fishermen. (This is roughly equivalent to the 12" fork length current legal limit in Delaware.) Although these

do not represent any additional restrictions on Delaware commercial fishermen, it would cause a noticeable decrease in Chesapeake Bay commercial harvests if everyone complied.

The Citizens Advisory Committee requests that you voluntarily comply with the above size limits and bag limits until the stocks of striped bass recover to high levels."

WHITE PERCH (*Morone americana*) RESOURCE IN DELAWARE

The white perch is one of the few estuarine finfish that inhabit Delaware waters throughout the entire year. White perch inhabit estuarine waters from Nova Scotia to South Carolina, and many landlocked populations exist in fresh water ponds and lakes (Woolcott, 1962). In the Delaware estuary, white perch is ranked as one of the most abundant resident fish species (de Sylva et al, 1962; Abbe, 1967). White perch populations in Delaware exist in nearly all tidal streams and rivers. Landlocked populations exist in most mill ponds and lakes throughout the state. White perch appear to be considerably less abundant in the Indian River estuary, and low level populations there are attributed to minimal amounts of fresh water entering the estuary (Wong and Kernehan, 1979). In other areas, as in Delaware, the white perch is often and incorrectly called the black perch.

Adult and juvenile white perch over-winter in the deeper portions of tidal rivers, Delaware River, and Delaware Bay. White perch spawn in the early spring, generally near the headwaters of tidal creeks and rivers. Most spawning appears to occur in oligohaline (less than 3.0 ppt) water when water temperatures reach 10°C. Male fish arrive on the spawning ground before the females.

White perch migrate from their over-wintering areas to their spawning areas shortly after the breakup of winter ice. Commercial and recreational net fishermen usually catch white perch in the Delaware Bay during the late winter while the fish are moving

toward spawning grounds. Spawning occurs from March through April They can be caught by hook and line fishermen throughout most of the warmer months of the year in tributaries of the Delaware River and Bay. The white perch in Delaware is a near shore fish, and consequently bank fishermen catch more white perch than boat fishermen. In the late fall (November), white perch and most young leave the tidal tributaries and migrate to deeper waters in Delaware Bay for over-wintering. Migrating white perch can be caught in nets during late fall and early winter in Delaware Bay until the formation of the first winter ice restricts gill netting activity.

The relative abundance of white perch in Delaware waters has apparently varied throughout the years. Commercial white perch landings (Table 17) have also fluctuated. Otter trawls accounted for 92 percent, or 111,800 pounds of the near record commercial white perch landings in 1958. Otter trawls are illegal fishing methods in Delaware Bay at the present time.

The 1978 average price of $.21 per pound is not considered to be a realistic value, especially since the landed value of nearly all other fish increased in 1978. Informed contacts with commercial net fishermen indicate that better prices were at times being received.

The flesh of the white perch is firm and flavorful, and the roe of the female fish is favored by many commercial and recreational fishermen. In fact, most commercial net fishermen in Delaware

TABLE 17

COMMERCIAL WHITE PERCH LANDINGS IN DELAWARE

Year	Pounds	$ Value	Avg. Price/Lb.
1947	138,000	9,000	.07
1948	51,000	6,000	.12
1949	47,000	2,000	.04
1950	49,000	6,000	.12
1951	74,000	9,000	.12
1952	12,000	1,000	.08
1953	9,000	1,000	.11
1954	23,000	2,000	.09
1955	15,000	2,000	.13
1956	8,000	1,000	.13
1957	11,000	1,000	.09
1958	121,000	12,000	.10
1959	42,000	4,000	.10
1960	13,000	1,000	.08
1961	27,000	2,000	.07
1962	24,000	1,000	.04
1963	21,000	2,000	.10
1964	28,000	3,000	.11
1965	27,000	3,000	.11
1966	39,000	5,000	.13
1967	21,000	2,000	.10
1968	15,400	2,154	.14
1969	8,600	1,290	.15
1970	16,200	2,430	.15
1971	18,300	2,945	.16
1972	18,100	3,620	.20
1973	23,000	6,842	.30
1974	18,100	3,718	.21
1975	15,300	4,074	.27
1976	17,600	4,901	.28
1977	27,500	8,955	.33
1978	34,000	7,051	.21

consider white perch to be the best fish to eat and far superior in flavor to the more highly valued catches of striped bass and flounder.

In recreational fishing surveys conducted in Delaware in 1968 (Lesser, 1968) and 1971-73 (Martin, 1973), white perch accounted for almost 50 percent of the fish caught in the Delaware River and tributaries north of Woodland Beach. Bank fishing effort for white perch north of Woodland Beach has seemed to decrease in recent years.

AMERICAN SHAD (Alosa sapidissima) RESOURCE IN DELAWARE

Along the Atlantic Coast, the range of the American shad extends from the St. Johns River in Florida to the Gulf of St. Lawrence, Canada. Shad are most abundant from North Carolina to Connecticut. The American shad was successfully introduced to the West Coast, and now their range extends from Mexico to Cook Inlet in Alaska.

The American shad is the largest member of the herring family (Clupeidae) and is an anadromous species that lives and grows in marine waters until sexually mature. Mature fish migrate into estuaries and ascend coastal rivers to spawn. Eggs hatch in six to eight days at temperatures of 17°C. (Bigelow and Schroeder, 1953). Larvae and young remain near the spawning areas until the fall when they migrate downstream to the sea where they will live and grow for two to five years before attempting to return to their natal streams to spawn. Male fish usually become sexually mature one year earlier than female shad. Southern races of shad apparently die after spawning once, but northern races have repeat spawners that migrate and spawn during two or more successive years. Shad do not live for long periods of time, and the average life cycle only extends from three to six years.

The shad fishery was one of the first commercial fishing industries to be established in Delaware. In the 1800's, shad were abundant in the Delaware estuary. Commercial landings along

the East Coast decreased in 1850 then increased to around 45 million pounds annually during the 1890's. Shad landings along the East Coast of the United States began a precipitous decline around 1900. Shad landings in the Delaware estuary exceeded 14 million pounds in the late 1890's and then declined to annual landing figures of less than 100,000 pounds in 1975 (Miller et al, 1975).

The decrease in commercial shad landings has been attributed to gross pollution, damming of tributaries and over fishing. In the Delaware River, pollutants have caused a significant decrease in dissolved oxygen levels in a 60-mile section of the river between Trenton and Wilmington (Kiry, 1974). Young-of-the-year shad have generally been unable to migrate downstream through the stretch of deoxygenated water. Mature fish that have spawned and are in a weakened condition are also unable to pass through the deoxygenated zone, and nearly all the repeat spawners have been lost. Relatively recent pollution abatement laws have improved the Delaware River water quality in recent years, and reasonably good shad runs occurred in 1963 and again in 1976.

It is highly unlikely that the shad populations of the Delaware estuary will ever approach the historical levels of the late 1800's. Most of the major and minor tributaries (Brandywine, Schuylkill, and Lehigh Rivers) have been dammed for a long time, and shad have been prevented from entering large acreages of formerly productive spawning grounds.

Shad fishing pressure was intense during the late 1800's, and the entire shad resource could have suffered irrepairable damage

because of over fishing. During the 1800's, more than 1,000 men may have been engaged in commercial shad fishing along the Delaware River (Horn, 1957). New Castle, Wilmington, Delaware City and Port Penn were major shad landing ports, and shad were also landed at many other towns and river landings along the Delaware side of Delaware River and Bay. Initially, shad were abundant and quite inexpensive. The fish were often sold for only a few cents each, and shad quickly became a staple food item in the diet of town and city residents. The shad fishermen sold their fish to fish markets and fish peddlers who often sold fish from door to door. During the late 1800's and continuing into the early 1900's, the flesh of the shad was highly regarded as excellent food, and the roe of the female shad was an equally popular food item. As the shad resource declined, the price of shad began to increase, but fish consumers evidently liked shad and continued to purchase them when the price of shad increased to $.25 per pound.

The consumption of shad decreased rapidly during the post World War II period,and younger generations had little desire to consume shad which were considered to be too boney or too oily. Older generations still purchase a few shad each year. In fact, shad fishermen of today have difficulty in marketing their limited catches because today's consumers prefer fish with fewer bones. The shad roe is still popular, and the value of the fish roe is usually much higher than the value of the entire fish. Female shad are usually a little larger than male shad and have always commanded a higher price. Recent Delaware shad landings are shown in Table 18.

TABLE 18

COMMERCIAL SHAD LANDINGS IN DELAWARE

Year	Pounds	$ Value	Price/Pound
1947	67,600	15,974	.24
1948	52,900	13,297	.25
1949	57,500	8,625	.15
1950	101,700	22,400	.22
1951	109,600	24,500	.24
1952	64,900	17,143	.26
1953	50,000	17,000	.34
1954	55,000	7,000	.13
1955	32,000	7,000	.22
1956	12,000	4,000	.33
1957	4,000	1,000	.25
1958	9,000	6,000	.67
1959	28,000	4,000	.14
1960	38,000	6,000	.16
1961	90,000	13,000	.14
1962	118,000	15,000	.13
1963	100,000	13,000	.13
1964	150,000	19,000	.13
1965	110,000	16,000	.15
1966	56,000	9,000	.16
1967	26,000	5,000	.14
1968	12,000	2,000	.17
1969	18,000	2,000	.11
1970	13,000	1,000	.07
1971	8,000	5,000	.63
1972	9,000	1,000	.11
1973	8,000	1,000	.13
1974	8,000	1,000	.13
1975	18,700	3,831	.20
1976	35,600	8,077	.23
1977	74,500	15,332	.21
1978	69,900	19,790	.28

A small sport fishery for shad occurs in the Brandywine River when shad occasionally enter the river seeking a place to spawn. In the late 1960's, shad repeatedly entered the Brandywine River and attempted to ascend dams in order to spawn in the higher reaches of the river. The State of Delaware spent almost one-half million dollars constructing fish ladders at dam sites on the Brandywine. Unfortunately, when these fish ladders were completed, the shad stopped entering the Brandywine. It is now theorized that shad only enter the Brandywine when they are unable to migrate up the Delaware River because of low dissolved oxygen levels.

Delaware has also been active, as well as the states of New Jersey and New York, in opposing the Tocks Island dam project on the Delaware River. Construction of the dam would make the remaining shad spawning area in the Delaware River inaccessible. At most of the dam sites where fish ladders have been installed, shad have avoided utilizating them. Shad have consistently refused to enter nearly all manner of fish ascending devices.

AMERICAN EEL (*Anguilla rostrata*) RESOURCE IN DELAWARE

American fresh water eels are found in nearly all marine and fresh waters throughout Delaware. Commercial eel landings in Delaware have increased since 1970 when the value of live eels began to increase. The 1978 eel landings of 188,100 pounds, valued at $119,051, were by far the highest and most valuable landings of eel ever recorded in the state. The 1978 eel landings were almost twice those reported for 1977 (Table 19). In the spring of 1979, eel buyers were paying eel fishermen one dollar per pound for live eels. This is the highest value that Delaware eel fishermen have ever received for their catches. In fact, in terms of landed value per pound, the value of live eels is currently equal to the per-pound value of commercially landed flounder, but the commercial eel fishery is much more valuable to the state because of the higher volume of eels that are regularly harvested. Live eels are now ranked along with striped bass and summer flounder as the only three finfish in Delaware that are commercially valued at one or more dollars per pound. The dramatic increase in the value and marketability of live eels in Delaware is due almost entirely to the expansion of the live eel market in the Netherlands and Japan.

Eels have always been highly valued as excellent food throughout Europe and the Orient. American fish consumers apparently never developed an appreciable taste for eels, possibly because of the abundance of more appetizingly aesthetic fish species. Eels were generally considered to be a nuisance by most recreational fishermen.

TABLE 19

COMMERCIAL EEL LANDINGS IN DELAWARE

Year	Pounds	$ Value	Avg. Price/Pound
1947	13,000	1,300	.10
1948	18,200	1,820	.10
1949	57,400	8,780	.15
1950	34,000	5,405	.16
1951	5,200	1,045	.20
1952	34,200	3,420	.10
1953	41,000	7,000	.17
1954	36,000	8,000	.22
1955	11,000	1,000	.09
1956	15,000	2,000	.13
1957	38,000	3,000	.08
1958	26,000	3,000	.12
1959	27,000	3,000	.11
1960	7,000	1,000	.14
1961	6,000	1,000	.17
1962	10,000	1,000	.10
1963	12,000	1,000	.08
1964	12,000	2,000	.16
1965	34,000	5,000	.15
1966	32,000	5,000	.16
1967	32,000	5,000	.16
1968	35,200	4,900	.14
1969	44,200	5,304	.12
1970	58,300	11,732	.20
1971	99,700	19,779	.20
1972	45,000	11,250	.25
1973	60,500	21,175	.35
1974	67,500	23,625	.35
1975	64,300	25,141	.39
1976	80,900	32,594	.40
1977	9[illegible],900	49,281	.51
1978	188,100	119,081	.64

Originally, the commercial eel fishery in Delaware consisted of only a handful of watermen who sporadically fished for eels. Eels were caught in pots and fykes and dip netted near the Doxee Clam Plant in Lewes. A large portion of the Delaware eel catch was salted and sold as crab bait. Salted eels were, and still are, the preferred bait for crab trotlines. Most of the salted eels were sold to Maryland commercial crabbers who continued to use crab trotlines for many years before finally switching over to crab pots. Now, there is only a limited market for salted eel crab bait in Maryland.

In practice, the medium and smaller size eels were salted for crab bait. The crabbers did not want the larger size eels for several reasons. The crabbers were primarily interested in obtaining a large number of eels, and consequently a large number of baits from each pound of salted eels. They disliked the use of large eel baits because the larger baits were difficult to pass over the trotline rollers. Basically, the crabbers were not interested in feeding crabs with the larger baits but were more interested in attracting crabs to the trotline with the smaller baits.

Large eels were held alive in eel live cars and eventually sold to an eel buyer. Eel buyers paid fishermen from ten to fifteen cents per pound for live eels. They would then load the eels into tank trucks and haul them to metropolitan areas where live eels could be marketed to certain ethnic groups. At various times, the smallest size (pencil size) could also be held alive and sold to bait dealers,

who in turn would sell the small eels as live bait to striped bass fishermen. The overall decrease in the striped bass population has somewhat curtailed the sale of live bait eels.

Commercial eel fishing pressure in Delaware began to increase in the 1970's when live eel prices began to rise after live eels were successfully shipped to Europe by boat. Eels can respire out of water for several days providing they are kept cool and moist. Eels from Delaware are now shipped to the Netherlands by air freight. The eels are held in trays and kept cool and moist by melting ice water. In April 1978, special interest legislation was introduced and passed by the 129th General Assembly that required resident commercial eel fishermen to purchase a $100 eel fishing license. The fee for non-resident commercial eel fishermen was established at $1,000 per license. The new law also required that all commercial eel pot markers had to be identified with the letter, "E", and also the license number of the commercial eel fisherman. The legislative act was historic in that it was the first and only license requirement for a commercial finfish harvested entirely within state waters. Commercial licenses have long been required for the commercial harvesting of clams, crabs, oysters, and most recently, lobsters. The eel legislation also clearly omitted establishing pot limits and the requirement of reporting catch data. All existing commercial shellfish licenses in Delaware are issued contingent upon reporting catch and effort data. The existing eel regulations should be reviewed and possibly rewritten in order to preserve and protect the eel resource in the state.

The State of Delaware has historically owned the Delaware River to the mean low water level in New Jersey. Ownership of the river extends from Artificial Island, northward to the Pennsylvania State Line. A 1905 compact between New Jersey and Delaware, dealing with common fishery rights and reciprocal fishing laws, has recently been found to be null and void. Commercial eel and crab potters from Delaware now have exclusive rights to fish in waters on the New Jersey side of the ship channel north of Artificial Island. This might cause problems in attempts to cooperatively manage fish resources.

During 1978, 18 commercial eel licenses were sold to Delaware residents. As of May 17, 1979, 19 commercial eel licenses were sold including one out-of-state license. It appears that during the past two years, the number of fishermen that are entering the commercial eel fishery is almost equal to the number of eel fishermen leaving the fishery each year.

The life history of European and American fresh water eels was reported by Johannes Schmidt in 1922. American eels, A. rostrata like their European counterparts, A. anguilla, are catadromous, and sexually mature eels of both species spawn and presumably die in the Sargasso Sea region near Bermuda. Thus far, no sexually mature fresh water eels have ever been found in the wild, but spawning is presumed to occur during early spring. American eel larva travel for one year before arriving along the Atlantic Coast of Canada and the northern United States. American eel populations

are basically found in temperate zones along the East Coast of the North American continent. Some eels have been reported as far south as the Equator. Fresh water eels do not occur along the West Coast of North or South America. Upon their arrival in coastal waters, eel larva metamorphose into transparent elvers that are called "glass eels". The glass eels enter estuaries where they attain a slightly darker color. During the late spring, swarms of these tiny eels can be seen at the spillway base of most mill ponds in Delaware. The elvers continue their migration into nearly all fresh water rivers, lakes and streams. Sex determination of eels is quite difficult, but it is known that nearly all large eels are females, and female eels migrate further and stay longer in fresh water than the males. Male eels grow to be only about one-half the size of females, and most male eels are found in brackish and marine waters. In the fall, mature eels migrate out of the rivers to the sea presumably to spawn. Eels apparently grow slowly and might require seven to fifteen years to attain mature size. Eels have been reared to a marketable size in two years in aquacultural systems.

ATLANTIC MENHADEN (*Brevoortia tyrannus*) RESOURCE IN DELAWARE

The Atlantic menhaden inhabits coastal and estuarine waters from Nova Scotia to Florida. A similar species, the Gulf menhaden (*B. patronus*) inhabits similar waters within the Gulf of Mexico. Menhaden have been one of the most abundant herring species (Clupeidae) of the Atlantic and Gulf Coast. Nearly all the commercial catch is processed into fish meal, fish oil, and condensed solubles. Menhaden are classified as non-food fish in the United States, and the annual menhaden landings far exceed the annual landings of any food fish in the United States. In 1977, menhaden accounted for 35 percent of the total U. S. commercial fisheries landings.

Menhaden spawn in offshore coastal waters during spring and fall migrations along the Middle Atlantic region (Higham and Nicholson, 1964). Eggs hatch within 40 hours, and larva move to oligohaline and fresh water nursery areas. The young-of-the-year fish remain in the upper reaches of shallow estuarine tributaries until the fall when young and older fish migrate southward to over-winter offshore from Cape Hatteras. Menhaden are planktonic filter feeding fish that travel in large compact surface schools.

The menhaden fishery is one of the oldest fishing industries in the United States, and the commercial fishery has been intensive and extensive in nearly all areas where menhaden have been abundant. In the New York area during the 1800's, small menhaden were canned and sold as "lunch fish" for several years before canned sardines became popular. Some menhaden have always been used as bait to catch other fish or crustaceans, but nearly all the commercial catch in the United States is processed and used as industrial ingredients in a number of products. Menhaden are extremely oily, and the early

menhaden processors were primarily in business to obtain tha valuable fish oil. As fish processing factories became more mechanized, large volumes of fish flesh and bone residues were produced, and these residues were initially sold as relatively cheap fertilizer. The fish residues had a high protein content, and after World War II, processed fish meal became much more valuable as a supplement to the poultry and animal foods.

The menhaden fishing industry in Delaware began in the late 1800's when the major Atlantic menhaden population center shifted from the Gulf of Maine to the mid Atlantic region. One of the first menhaden processing factories in Delaware was built in Lewes, Delaware in 1917. The processing plant was known as the Coast Oil Company. From 1923 until 1954, the Hayes brothers processed menhaden in the Consolidated Fisheries Company in Lewes, Delaware. The Hayes plant had two dozen steamers carrying menhaden and employed more than 600 men. In 1938, Consolidated Fisheries had the largest menhaden processing plant in the United States (Horn, 1957).

Around 1946, the Smith family began to operate a menhaden processing plant in Lewes on the site of an old processing plant that was formerly the Atlantic Fish Company. Smith renamed his first plant the Fish Products Company, and in 1954 Smith purchased the old Hayes plant and renamed it the Sea Coast Products Company. In 1953, Lewes had the highest seafood landings in the United States when 390 million pounds of fish were landed. Twenty five large company-owned menhaden steamers provided fish for the two Lewes plants, and more than 650 men were employed as crew members alone. Several hundred shore-based support and factory workers were also employed. Near record menhaden landings were also made in Lewes in

in 1956, but Lewes landings began a precipitous decline in 1962. In 1963, one of the manhaden plants in Lewes closed permanently. In 1966, the remaining menhaden plant closed permanently, and the plants and property have since been sold.

Some minor regulations in Delaware were established as law in an attempt to regulate the menhaden fishery. In 1974, a $100 fishing license was established for all menhaden steamers over 65 feet in length to fish in Delaware waters. The license requirement did not specify an increased license fee for out-of-state menhaden vessels, and consequently, these vessels do purchase $100 licenses that allow them to fish within Delaware waters. Menhaden fishermen are also required to fish no closer than one-half mile from all shores and beaches and are prohibited from fishing in Delaware waters on weekends and holidays.

Menhaden are nearshore coastal fish, and more than 95 percent of the entire menhaden catch is made within three miles of shore. Manhaden are caught with huge purse nets which encircle entire schools of fish. The menhaden fishing methods have caused many conflicts with nearshore recreational fishermen who suspect that the menhaden boats are also catching food fish. In fact, menhaden fishing boats rarely catch any edible fish. Menhaden fishing boat captains and airplane school spotters are quite experienced in recognizing menhaden schools. Menhaden fishing boats cannot make money by catching food fish because they do not contain nearly the amount of oil that is obtainable from menhaden. Repeated inspections of menhaden catches have revealed very few, if any, other species of fish.

During the years since 1966, menhaden have been continuously caught, although in lower commercial quantities, by boats originating from out of state (Table 20). Since the fish are landed at out-of-state ports, Delaware receives no credit for the millions of pounds of menhaden that are still caught annually in Delaware waters. The small volumes of menhaden that are recorded from 1972 were sold as bait to crabbers.

The entire menhaden fishing industry along the Mid Atlantic Coast expanded rapidly immediately after World War II. Shore processing facilities were mechanized and modernized along with the fish catching vessels. Exceptionally large catches of menhaden became possible when the size of the steamers was increased and nylon nets and hydraulic power blocks were used to pull in the larger purse nets. Airplane spotters were used to locate schools of menhaden and to assist the purse boats in surrounding the schools of fish with their nets. Total East Coast menhaden landings peaked during the late 1950's and then steadily declined during the early 1960's.

With the cessation of intensive commercial fishing in the Delaware region and the elimination of some of the heavy fishing pressure, the menhaden stocks in the mid Atlantic region appear to be building. It should be noted that it has taken almost ten years for the menhaden stocks to rebuild. In 1978, 21 Virginia based menhaden steamers purchased licenses to fish in Delaware waters. It is highly unlikely that menhaden will ever be processed for industrial purposes again in Delaware. However, menhaden might be processed as an additive to human food sometime in the future.

TABLE 20

COMMERCIAL MENHADEN LANDINGS IN DELAWARE

Year	Quantity (Pounds)	Value (Dollars)
1947	248,493,300	3,752,249
1948	148,302,500	2,053,152
1949	159,748,100	1,677,355
1950	151,857,500	1,548,947
1951	166,488,700	1,911,375
1952	207,657,100	2,018,102
1953	360,544,000	3,999,000
1954	306,480,000	4,476,000
1955	307,476,000	4,091,000
1956	352,947,000	4,625,000
1957	286,272,000	3,666,000
1958	269,667,000	3,776,000
1959	281,141,000	3,149,000
1960	280,711,000	2,751,000
1961	302,773,000	3,356,000
1962	268,704,000	2,783,000
1963	102,824,000	1,059,000
1964	32,554,000	378,000
1965	46,498,000	579,000
1966	4,231,000	53,000
1967	-0-	-0-
1968	-0-	-0-
1969	-0-	-0-
1970	-0-	-0-
1971	-0-	-0-
1972	29,000	1,000
1973	33,000	1,000
1974	13,000	552
1975	20,000	821
1976	35,300	1,404
1977	24,600	984
1978	29,700	1,485

A state/federal fisheries management plan is being drafted for the management of the menhaden resource in Delaware.

FISH HABITAT ASSESSMENT IN DELAWARE COASTAL WATERS

Delaware River water quality has improved during the past ten years. There still exists a problem with dissolved oxygen in the river above Wilmington from May through September, but the length and duration of this oxygen depletion zone has been reduced. Water flows at Trenton are regulated by the Delaware River Basin Authority in an effort to insure that the saline waters of the Delaware Bay do not encroach up the river. In many places, the Delaware River looks cleaner than it has been in many years.

Unfortunately, many acres of shallow water and adjoining wetlands have been permanently lost over the past century to industrial and highway development along and in the Delaware River. Striped bass spawning habitat in the Delaware River has all but been eliminated due to low dissolved oxygen levels.

Years ago in the late 1800's, American shad made spawning runs in nearly all the tributaries of the Delaware River. Now, shad spawn only in the section of the river above the Delaware Water Gap. However, some of the river herring still make a spawning run in a few of the Delaware River tributaries. The young clupeids use the spawning grounds as nursery areas during the spring and summer. During the fall, the young-of-the-year fish migrate down the river and through Delaware Bay and out to sea. Migrations through the polluted zone are sometimes difficult, but the general increase in rainfall during the fall season helps to dilute and break up the low dissolved oxygen zone.

The waters in the heavily industrialized portions of the Delaware River pass through many water intake structures where river water is used for domestic and industrial purposes. Several fossil fuel plants and one nuclear power plant use river water to cool their systems. It has been calculated that a volume of water equivalent to the average flow at Trenton is removed and replaced in the river below Trenton each day. Plankton and larval and juvenile fishes are entrained and impinged at these intakes, and the accumulative effects of all water intakes and effluents are not documented. Fortunately, environmental regulations adopted in recent years have eliminated many of the pollutants that once entered the river.

For the most part, Delaware Bay is not polluted by domestic or industrial pollutants. Heavy metal concentrations in the lower bay are considered to be moderate but will continue to be a threat. However, all the tidal tributaries that enter Delaware Bay are closed to molluscan shellfishing because of high coliform bacteria counts. Much of the pollution of these tidal tributaries is usually due to treated and untreated sewage effluents discharged from small municipalities. Natural oyster beds occurring near the mouths of the lower tidal tributaries in Delaware were declared to be polluted in the mid 1920's. At the present time, the tributaries and small buffer areas are the only areas in Delaware Bay that are closed for the harvesting of molluscan shellfish.

Siltation is a problem in many tributaries to the Delaware Bay. Extensive agricultural and highway drainage systems have

increased sediment loads entering these rivers with consequent filling and loss of spawning and nursery habitat. Vegetation has been eliminated from many tributaries in the Delaware watershed where sediment has covered them with blankets of mud. Recent increases in no-tilling farming methods may cause increased quantities of herbicides to be flushed into tributaries thereby threatening production of phytoplankton.

The lower coastal bays are apparently becoming more polluted as shown by high coliform bacteria levels recently recorded. Indian River has recently been closed to molluscan shellfishing to the west of Ellis Point. Over 20 percent of the coastal wetlands in these lower bays have been lost to dredge and fill operations and developers of waterfront housing communities. Fortunately, this exploitation of tidal wetlands is now under control and no longer permitted unless there are no alternatives available. Nevertheless, these lower bays remain stressed ecosystems. Flushing of these waters is inadequate to compensate for an ever increasing pollution load placed on them by nearby coastal communities and industries.

SOCIO-ECONOMIC VALUE OF FISHERIES AND COMMUNITY INVOLVEMENT

Recreational sea trout fishing in Delaware Bay has been exceptionally good since 1970. In 1975, croakers returned to Delaware waters after a mysterious absence of approximately 15 years. Recreational and commercial catches of summer flounder, or "fluke", also began to improve in 1975 when the marine recreational fishing industry was valued in excess of 25 million dollars. The increased availability of desirable bottom fish in Delaware Bay has resulted in a significant increase in the number of party, or head boats, fishing in Delaware Bay and near the mouth of Delaware Bay. Head boats are usually larger fishing boats that take a large number of passengers fishing for a fixed fee per person or head. Party boats usually sail every day from the same dock, departing at a prescribed time and returning to port after a specified time period. Trip durations vary from one-half day to a full day of fishing, and rates range from $8 to $15 per person. In contrast to charter boat fishing, party boat fishermen are not required to make any previous arrangements in order to fish on a party boat. Party boat fishermen can go to any party boat dock and pay a flat rate to go fishing. Most party fishing boats are licensed by the U. S. Coast Guard to carry 20 to 50 or more persons. Party boats fish mainly for bottom species with bait or by jigging artificial lures to catch fish at various depths.

Party boats in Delaware generally fish for the fish stocks that are seasonally and locally abundant. They usually fish within

a 15-mile radius of their home dock. For example, party boats from Indian River and Lewes will usually fish for Atlantic mackerel in the Atlantic Ocean during the early spring. Party boats based further north in Delaware Bay at Mispillion and Bowers Beach usually stay in Delaware Bay to fish for trout and flounder. By the same token, party boats from Indian River will not ordinarily fish for trout in Delaware Bay because the running time and distance is prohibitive.

Recreational fishing from boats is usually much more productive than fishing from shore, and party boat captains who fish almost every day during the summer usually know where fish are biting and how to catch them. Party boat fishing is probably the least expensive method of fishing from a boat in Delaware, with the operation of party boats more profitable than most charter boats. There are approximately 20 party boats now operating in Delaware, and all but two of these vessels are operating in or near Delaware Bay.

Charter boat fishing in Delaware is always more expensive and is generally more productive than party boat fishing. In charter boat fishing, the fishing vessel is usually rented (chartered) for one day at a specified rate to engage in a specific type of fishing such as trolling or bottom fishing. Trolling charters for offshore species such as marlin or tuna are always more expensive than trolling rates for inshore species such as bluefish because offshore trolling expenses are greater.

Many of the smaller charter boats are licensed by the U. S. Coast Guard to carry a maximum number of six fishermen. Charter rates include the use of bait or lures, rods and reels, and the services of a professional "mate" to assist anglers in landing fish. Although charter boat fishing is much more expensive than party boat fishing, the catch rate per angler on charter boats is usually much greater for several reasons. Charter boats are usually smaller than party boats and always less crowded. They can fish in tighter places and maneuver more frequently than larger party boats that are often crowded with fishermen. Charter boats also can engage in trolling in order to catch fish while the boat is underway, but party boats do not troll because of the number of fishermen involved.

Charter boats of sufficient size and seaworthyness can be licensed to carry more than six persons if provision is made for the installation of additional safety and lifesaving devices. The boats that are licensed to carry more than six passengers will sometimes carry additional passengers on a chartered fishing trip but only at the request of the fishing party who originally chartered the vessel. Additional passengers on charter boat trips are required to pay an additional flat rate per person. In this manner, charter boats that are licensed to carry a large number of passengers often operate in a manner similar to party or head boats. Many party boats make two fishing trips each day, operating as a regular party boat on the first trip and chartering the vessel

to a smaller number of persons for the second trip of the day. There are approximately 100 charter boats that now operate regularly from Delaware ports. Slightly more than half (55 boats) of the charter fleet operate out of marinas on the Indian River Inlet. The remainder of the charter fleet operates out of the Delaware Bay ports of Lewes, Mispillion River, Cedar Creek, or Bowers Beach.

In addition to the party boats (20) and the charter boats (100), there are more than 18 thousand privately-owned boats that fish, crab, and clam regularly from Delaware ports, marinas and boat ramps during the warm months of the year. Finally, several thousand additional fishermen regularly fish Delaware tidal waters from beaches, banks, bridges and piers. In 1975, the recreational fishing industry in Delaware was valued at 25 million dollars (National Analysts, 1977). A marine boat recreational survey conducted in 1976 (Miller, 1977), revealed that 599,615 man days of boat fishing occurred in Delaware during 1976, and the total man days of marine angling amounted to 964,573. Tourism in Delaware contributes approximately 100 million dollars to the state economy, and marine recreational fishing generates approximately 25 percent of the annual tourism dollars.

The marine recreational fishing industry provides direct employment for around 125 boat captains and more than 100 mates. Recreational fishing has a rippling effect on the local economy because the additional fishermen require more services such as rooms, meals, bait, ice, etc. The additional services provide more jobs and business opportunities at the local level.

The fish and shellfish resources on which the recreational fishing industry depend are undoubtedly one of the most valuable natural resources within the state. It is not surprising that many of the fish species,that are so important to the recreational fishing industry,are also just as important to the commercial fishing industry. As the landed value of all food fish continues to increase, a corresponding increase in conflict between recreational and commercial fishermen will definitely occur.

One of the major problems encountered in attempting to manage natural marine resources occurs when regulatory agencies try to define, or draw the line, between what constitutes commercial or recreational fishing. Commercial trawlers and net fishing boats are obviously commercial fishing vessels. Commerciality is defined as having financial profit as a primary aim. Commercial fishing vessels are obviously in business to fish commercially, but the party and charter boats have definitely commercialized recreational fishing. Many of the larger private fishing boats are owned by corporations or by persons who are engaged in their own business. Part of the cost of buying, maintaining, and operating a large private fishing boat can be written off as legitimate business entertainment expenses.

An unknown number of private boats that participate in marine angling rely on the sale of fish to help defray all or part of their boating expenses. The practice of selling or utilizing recreationally caught fish to defray expenses or make a profit is not limited to private fishing boats. Many of the marine anglers

who fish from shore, party, or charter boats regularly sell their excess fish and also fish that they are not particularly fond of eating. Some restaurants own their own fishing boats, and some restaurant owners charter fishing boats in order to provide fresh fish for their establishments.

The problem in defining recreational and commercial fishing is further complicated in Delaware because of a long established and traditional recreational net fishery. Net fishing regulations in Delaware have been minimal and are virtually unenforced. The State Legislature has at various times passed special interest legislation restricting or prohibiting the use of certain types and sizes of nets in certain areas during specific hours and specific times of the year. Although most of these laws are still in effect the laws are seldom enforced because of conflicting statutes and antiquated intention of the laws. The State Legislature has not specifically designated a state agency to be the regulatory authority for marine finfish. Commercial fishing licenses were not, and are not now required in Delaware. Almost anyone, if they so desire, can set a net in Delaware to catch a "mess" of fish for their family and friends. The occasional "just for the fun of it" net fisherman has, on occasion, caught more fish than he can conveniently give away. Some of these net fishermen are more or less obliged to sell their excess fish before they spoil. Some of the more successful occasional or recreational net fishermen eventually become serious commercial net fishermen. The desire to be allowed to set a net is still strong in Delaware.

Nearly all the food fish that are now reported as commercial landings in Delaware are caught in staked or drifted gill nets. The total value of all commercial fish landings in Delaware has been steadily increasing since 1974, as shown in Table 21. In the spring of 1979, the per-pound landed value of all food fish increased dramatically. Striped bass were sold for more than $2.50 per pound. Live eels and summer flounder also reached $1 per pound. The increased value of all fish will undoubtedly tempt more recreational fishermen to sell their catches.

Although the prices of commercially caught finfish are slowly increasing (Table 21), the total value of all commercial fisheries landings in Delaware has been steadily decreasing (Figure 1). The landed value of all commercial fisheries was only three quarters of a million dollars in 1978. Surf clam landings accounted for a significant portion of the total fisheries value during the period from 1969 through 1974. The value of blue crab landings from 1972 through 1977 also made a significant contribution to the total fisheries value.

The number of persons actively engaged in commercial fishing in Delaware is now estimated to be less than 200. Delaware's highest recorded number of full and part-time commercial fishermen was 1,434 persons in 1957. Gainful employment in the fishing industry in Delaware has steadily declined, and the official count of 548 persons in 1974 (Table 22) must include a large number of casual fishermen.

Commercial fishing in Delaware does not create a large number of indirect benefits to local communities at the present time. Even the Delaware seafood consumers seldom benefit from commercial seafood

TABLE 21

RECENT TOTAL FINFISH LANDINGS AND VALUES

Year	Pounds	$ Value	Avg. Price/Lb.
1968	160,900	24,029	.15
1969	143,000	20,338	.14
1970	300,600	59,227	.20
1971	431,900	91,567	.21
1972	810,500	141,248	.17
1973	151,700	290,561	.26
1974	758,500	189,471	.25
1975	797,200	205,969	.26
1976	727,500	231,328	.32
1977	945,500	256,042	.27
1978	938,600	336,816	.36

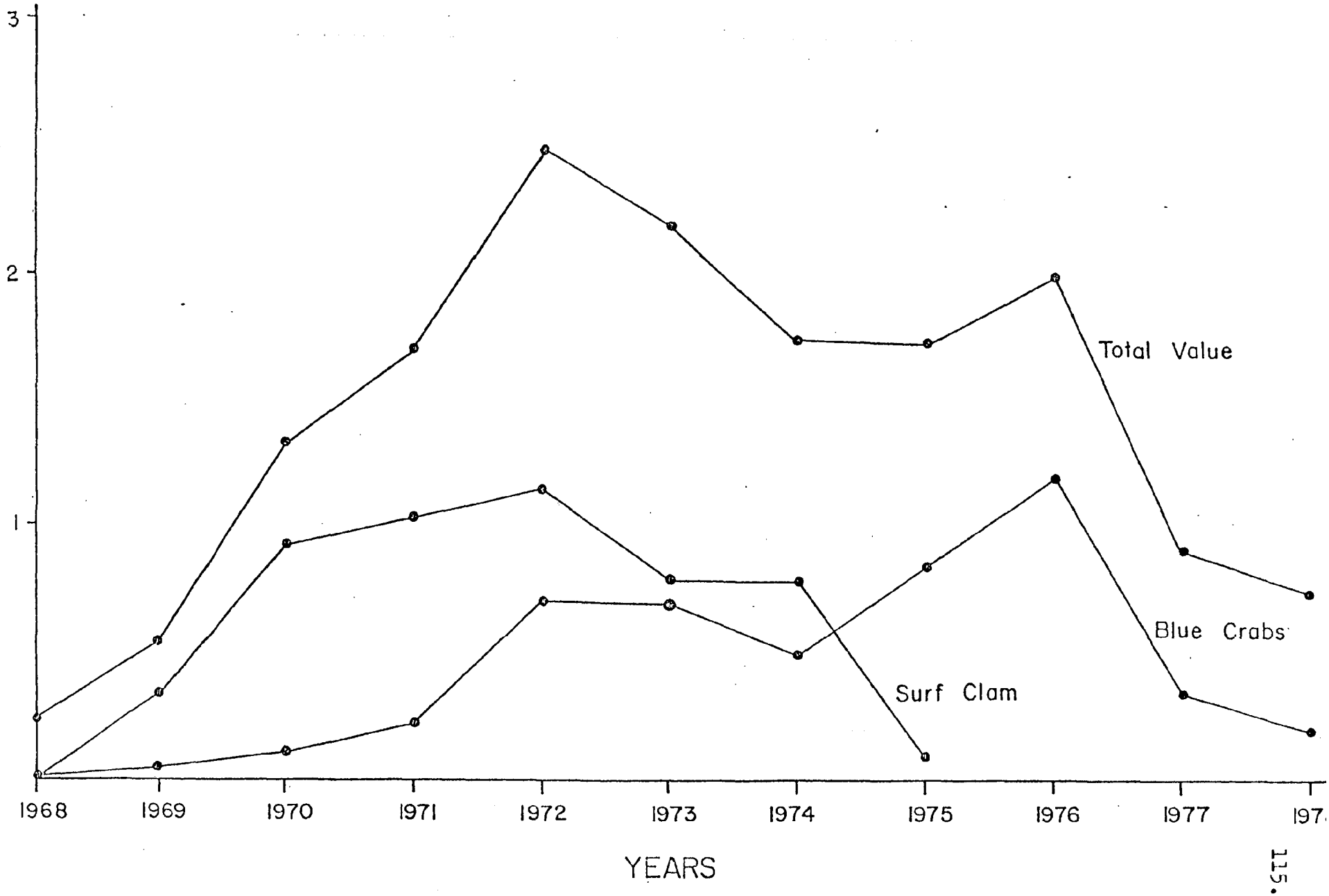

Fig. 1. Total value of commercial Fisheries landings in Delaware

landings in Delaware because a large portion of the seafood catch is sold to out-of-state wholesale buyers. Employment of Delaware residents in the commercial fishing industry is relatively low, and crew members are often recruited from out of state.

TABLE 22

FULL AND PART-TIME EMPLOYMENT IN THE FISHING INDUSTRY IN DELAWARE

Date	Number	Date	Number
1947	1,207	1963	662
1948	1,320	1964	691
1949	1,050	1965	520
1950	1,143	1966	449
1951	1,076	1967	445
1952	918	1968	433
1953	1,050	1969	462
1954	1,189	1970	623
1955	1,321	1971	714
1956	1,257	1972	667
1957	1,434	1973	541
1958	1,384	1974	548
1959	894	1975	-
1960	719	1976	-
1961	781	1977	-
1962	742	1978	-

IDENTIFICATION OF FISHERY PROBLEMS, ISSUES AND OPPORTUNITIES

After a careful consideration of coastal fisheries throughout Delaware, certain problems, issues and opportunities regarding development and management have been identified. Foremost and common to all aspects of Delaware's coastal fisheries is the absence of any dominant policy upon which the state bases fisheries management and development programs.

The drastic decline in commercial fisheries, as evidenced by the closing of the menhaden processing facilities at Lewes without any concentrated effort to attract new fishery related industries as replacements indicates the lack of a commercial finfish policy. However, recreational fishing activity in Delaware Bay has increased dramatically as commercial fishery landings have declined. Recreational fishing activities now far outweigh the benefits of encouraging the intensification of near shore commercial fishing effort. Conflicts exist at the present time, and these conflicts will increase as commercial and recreational fishermen attempt to catch fish in the same area and at the same time. Policy guidelines might aid in the management of these situations.

In order to develop a comprehensive fishery policy, several other subordinate problems, issues and opportunities must first be analyzed.

The apparent success of the Fisheries Conservation and Management Act of 1976, which has created new opportunities for domestic fishermen to fish for species previously depleted by foreign fishing fleets, also has created the opportunity for development of

deep water fishing port facilities, especially in the Middle Atlantic area. Breakwater Harbor, in Lewes, is ideally located in relation to the offshore fish stocks in the Fishery Conservation Zone (3 - 200 miles) off the Middle Atlantic states. The present owner of the former menhaden processing plants at Breakwater Harbor is rebuilding the piers and rehabilitating existing warehouses and utilities and advertising leases to fishery related industries. Appropriations have been approved by the U. S. Congress for dredging the access channel to Breakwater Harbor to a depth which will allow all but the largest of fishing vessels to dock there.

A dedicated effort should be made by the Department of Natural Resources and Environmental Control, Office of Management, Budget and Planning, and the Division of Economic Development to encourage the orderly development of these port facilities in compliance under environmental and local and county guidelines. The staffs of these departments should act as liaison between the owners, Lewes officials, county officials, and potential fishermen, fish buyers, processors, and marketing agents.

Considering the fact that many offshore (3 - 200 mile) species of fishes are now being managed under fish management plans developed by the Regional Fishery Management Councils and implemented by the Secretary of Commerce, the need for management of many inshore species in the territorial seas (0 - 3 miles) and inland waters of Delaware is becoming more apparent. Anadromous fishes may either be regulated

by the state or preempted from state control by a fish management plan as implemented by the Secretary of Commerce. To date, there has been no preemption by the Federal Government to manage any inshore species, but problems with managing these species are increasing. Also apparent, as a problem, are those species of fish which migrate between states that have vastly different laws and regulations pertaining to these fish. Consequently, the management of these stocks can be splintered and contradictory between adjoining states. The jurisdictional level of fisheries management is, therefore, a major problem confronting coastal states. An equitable allocation of fish stocks between states for both recreational and commercial interests must be addressed to conserve these stocks.

The issue to be addressed in Delaware is whether or not regulatory authority for coastal fisheries should be authorized by the legislature to the DNREC. Both the political and scientific conservation of natural resources are delicate points in this issue. Much consideration should be given to the local economy and best use of our fishery resources. However, to insure the continuation of the fishery and the preservation of a species, decisions must be made in a timely and open fashion. The question is whether the legislature, DNREC, or another form of authority might be in the best position to make these decisions. The DNREC has the technical staff and the experience in dealing with marine fisheries enforcement problems since they are the designated enforcement agency for existing finfish statutes and shellfish regulations.

Regardless of which agency determines the management of an inshore fishery, an adequate data base on catch and effort by fishermen, reliable fish stock assessment and the socio-economics of the fishery must be collected and competently analyzed. This is a problem in Delaware. A system should be established, either mandatory or voluntary, to enable the DNREC, in cooperation with other states and federal agencies, to collect these statistics from fishermen in addition to the biological and ecological data regarding the resources. Conserving fish stocks while allocating the maximum sustainable yield to both recreational and commercial fishermen is a major issue and should be addressed.

Another problem in coastal fisheries in Delaware is lack of public understanding of coastal fisheries management and the consequent reluctance to accept management of marine fisheries. Many individuals think of fisheries management in coastal waters as being similar to that practiced with fresh water lakes where stocking new species of fish and reclamation projects have been successful. These individuals fail to realize that the ocean, bays and tidal rivers have their limits, and fisheries management in these coastal environs involves many more aspects than restocking depleted species. A program should be designed to administer an integrated information, education and enforcement program for coastal fisheries management.

The final issue identified is related to all the above problems and issues for coastal fisheries in Delaware - the question of how to finance coastal fisheries management programs. Different

sources of possible revenue have been identified. These include a recreational fishing license, a commercial fishing license, additional boat registration funds, area user fees, unclaimed, off-road gasoline taxes and additional general fund appropriations. These new sources of revenue, other than general funds, should be dedicated to marine fisheries management programs and not subject to indiscriminant budget reductions or diversions by special interest groups.

Presently, most of the DNREC's coastal fisheries management is funded with the following federal grants in aid: (1) Federal Aid in Fish Restoration Act (Dingell-Johnson Act - P.L. 81-681); (2) Anadromous Fish Conservation Act (P.L. 89-304); and (3) Commercial Fisheries Research and Development Act (P.L. 88-309). Each of these, however, requires a proportional matching amount from the state, and it is these matching funds that are in short supply.

Only those who harvest certain shellfish in Delaware are required to be licensed. Licensing fishermen would serve the dual purpose of identifying fishermen for the gathering of catch and effort statistics as well as increasing revenues. Another value of licensing is that the true number of commercial fishermen could be defined and substantiated in disputes with offshore oil support facilities, oil spills, fish kills, CZM planning, etc.

Each possible source of revenue should be analyzed thoroughly. If legislation is required to generate or dedicate these revenues, it also should be prepared.

RANKING OF PROBLEMS, ISSUES, AND OPPORTUNITIES

The purpose of the second task in this program is to rank the problems, issues and opportunities associated with Delaware coastal fisheries. Each problem, issue and opportunity previously described is inter-related, but some need more immediate attention than others.

Priority Number One

The first issue that should be considered, but not necessarily resolved immediately, is a state policy for coastal fisheries. Coastal Zone Management issues must consider coastal fisheries. However, without policies to serve as a guide, decisions involving management of the coastal zone may be delayed pending impact analyses on present fisheries and future fisheries potential. A sound fishery policy would greatly assist in the decision making process.

Priority Number Two

The most obvious opportunity is the current and almost urgent need for a Middle Atlantic fisheries port to accommodate increased fishing fleets fishing in the Fisheries Conservation Zone (3-200 miles). Breakwater Harbor and adjoining piers and property in Lewes of the former menhaden processing plants are ideally situated for port development. Other Middle Atlantic ports (Cape May, N.J., Ocean City, Md., and Chincoteague, Va.) are over crowded and have shallow depths in their inlets. Breakwater Harbor has recently been approved for dredging, has no inlet to shoal, and has ample room for dockage facilities as well as storage, fuel, ice, transportation and community interest in this type of development.

Other states are actively advertising for fishermen and fish packers, processors, shippers and marketing agents to locate at their ports, and Delaware should exert equal effort to attract these seafood industries to Lewes.

Priority Number Three

A problem that presently complicates coastal fisheries management is the present set of laws pertaining to marine fishing. Many of these laws were enacted over 50 years ago when fishing vessels used sail power and steam engines, and refrigeration was not yet available. Legal methods of fishing and restrictions on various species of fish are no longer applicable in most cases. The public is often confused, justifiably so, when interpretation of the antiquated laws requires

an attorney's legal opinion. In essence, the entire Delaware Code related to coastal fisheries should be redrafted and submitted to the Legislature for consideration.

Priority Number Four

Coastal fisheries management should be based on timely, and the best available, scientific and socio-economic data. This legislation should include the granting of regulatory authority to the DNREC, with possible veto or approval from a legislative or appointed committee, establishing commercial fishing licenses, recreational fishing licenses, fishing gear identification and marking requirements, fish sanctuaries, and reporting requirement of catch and effort data. Much attention should be directed to the growing conflict between recreational fishing interests and expanding commercial fishing opportunities with modern fishing gear. Supply and demand for fish stocks could have profound effects upon Delaware's coastal communities in the very near future.

If coastal fisheries management is to be applied, using the best available scientific and socio-economic data, this information must first be collected and correcly analyzed. This will require either voluntary or mandatory keeping of records by commercial and recreational fishermen, fish buyers, fish processors and fish shippers. It also will include up-to-date field inventories of Delaware's fish stocks in coastal waters. An integrated system must also be developed in cooperation with other state fishery management agencies and the National Marine Fisheries Service (NOAA, U. S. Department of Commerce) for collecting data required of migratory stocks of fishes, and from the fishermen who pursue them beyond the three-mile territorial seas of adjoining states. Conserving fish stocks and allocating the optimum sustainable yields to both recreational and commercial fishermen is a critical management issue and should be resolved.

Priority Number Five

A recurring problem that hinders coastal fisheries management is the biased public opinion that formulates because of inaccurate theories and insufficient data. To help resolve this problem and correctly inform the fishing and non-fishing public, an integrated program involving information, education and enforcement of our coastal fisheries should be developed. Delaware's Marine Police should receive additional education in marine fisheries management in order

to provide accurate answers to the questions of the public. A package of materials related to coastal fisheries management should be compiled for distribution to boat owners, fishermen and conservation groups throughout Delaware.

Priority Number Six

Last, but not least, is the problem of funding coastal fisheries management. All options should be explored in order to address the financial needs of managing our fishery resources.

DEVELOP STRATEGIES AND OPTIONS TO RESOLVE PROBLEMS AND ISSUES IN ORDER TO FORMULATE FISHERIES MANAGEMENT PROGRAM

Several options exist for managing coastal fishery stocks. Various levels of federal and state authority and interstate agreements and commissions exist to manage fisheries. However, each has its own deficiencies, and an overall set of guidelines should be established and followed by all the states and federal authorities for a species of fish throughout its range.

The Atlantic States Marine Fisheries Commission (ASMFC) was a compact created to allow the Atlantic coastal states to better manage their marine fisheries. In 1950, the Atlantic States Marine Fisheries Commission made the first amendment to the existing compact between the Atlantic coastal states. This first amendment made provision for any two or more states to set up joint regulations for the management of common fisheries resources. Amendment No. 1 has not been ratified by the states of Delaware and New York.

The State of Delaware had previously entered into a compact with the State of New Jersey in 1905, years before the establishment of the ASMFC. The 1905 Compact established uniform fishing regulations for the common finfisheries shared by Delaware and New Jersey. Recently, it was determined that the 1905 Compact was never ratified correctly, and the compact is no longer considered valid. The enactment of the eel fishing license by the legislature directly discriminates against New Jersey fishermen in the Delaware River and totally ignores the provisions of the 1905 Compact.

It is imperative that Delaware and other coastal Atlantic states enter into working agreements with neighboring states in order to develop plans for the management of near shore migratory marine resources. State/federal programs, sponsored by the National Marine Fisheries Service and the ASMFC should be encouraged for regional or coastal management of fish species that migrate along the Atlantic Coast. If something is not done soon at the cooperative inter-state level, there is a good possibility that individual state fishery management rights might be preempted by federal involvement.

The State Legislature should consider delegating authority to the Department of Natural Resources and Environmental Control to regulate marine finfish in Delaware waters. Natural marine resource populations fluctuate so much that firmly established laws, seasons and limits are often detrimental to effective management of the resources and the livelihood of the fishermen. The state should also consider and provide more financial support to the Department in order that they might be properly equipped to manage and protect the marine resources within the state.

The Fishery Conservation and Management Act of 1976 was established primarily to manage offshore fisheries. However, the fishery conservation zone extends from the three-mile state territorial sea boundary to the 200-mile offshore limit. The Regional Fishery Management Councils are predominantly oriented toward the management of offshore fish stocks, and they have no authority in the management of coastal and regional inshore fish stocks. There

is a continuing effort to amend the Fishery Conservation and Management Act to extend the council's authority into territorial seas of the states if the states are unable to manage their own coastal fishery resources.

The regulatory authority for effective management of all marine fisheries resources in Delaware should be given to the Department of Natural Resources and Environmental Control. The Department also should be given the authority to license commercial finfishermen within the state. Licensing is required in order to obtain reasonably reliable catch and effort data on all fish stocks in Delaware.

OCEAN FISHERY PORT DEVELOPMENT IN DELAWARE

Implementatation of the 200-mile fishery conservation zone (FCZ) by the United States and similar action by other coastal nations has stimulated latent United States interest in offshore fishing. Fish consuming nations (Japan, Russia, etc.) with nationally subsidized distant water fishing fleets are no longer able to indiscriminately harvest huge quantities of fish close to the coasts of the United States and many other nations. It is true that enactment of the 200-mile fishery limit came only after many of the more valuable East Coast groundfish populations had been severely over-harvested by foreign fishing vessels. Regional fishery councils have been created to develop resource management plans for fishery resources with the FCZ.

Prior to the establishment of the 200-mile limit, offshore fishing by United States vessels was not especially profitable because shore-based U. S. fishing vessels could not compete economically against foreign labor, factory and nationally subsidized foreign fishing fleets. Foreign nations could catch and sell processed fish to U. S. fish buyers at prices much lower than the minimum prices required by U. S. fishermen.

Fish flesh has long been a significant source of protein throughout a large portion of the world. Fish consuming nations are faced with ever increasing fish shortages, and several fishing nations are exploring the possibility of purchasing huge quantities of fish from U. S. fishermen. The increased marketability of fish

now caught by United States fishing vessels is causing major conflicts within the regional fishery management councils.

In the New England fishery management zone, groundfish stocks of cod, haddock and yellowtail flounder have been seriously reduced, at least in part, by foreign fishing pressure. The elimination of the major foreign fishing pressures has resulted in a 50 percent increase in the number of U. S. vessels fishing for the same species. The New England Fishery Management Council is attempting to manage these groundfish resources by establishing catch quotas, but the New England fishermen are reluctant to accept most of the council management recommendations. Essentially, the increased marketability of white flesh fish (cod, flounder, etc.) is causing U. S. fishermen to exert increased fishing pressure on the existing New England groundfish stocks to a degree similar to that previously employed by foreign fishing vessels.

Within the mid Atlantic fishery management zone, and especially off the coast of Delaware, there are no large offshore stocks of the traditionally higher valued white flesh groundfish. Prior to the enactment of the 200-mile limit, the offshore fishery resources in the mid Atlantic region were abundant enough to keep several large foreign fleets fishing night and day throughout the warmer months of the year. Now, according to National Marine Fisheries Service surveys, previously under-utilized stocks of squid, butterfish and red hake are abundant enough to form the basis of a large and intensive mid Atlantic offshore trawl fishery.

The old menhaden plant docks and shore facilities just inside Cape Henlopen in Lewes, Delaware appear to be ideally suited for the development of an offshore ocean fishery port. It is important to emphasize the desirability of developing port facilities for vessels engaged in fishing for offshore and/or under-utilized fishery resources. The development of nearshore trawling fleet facilities should not be encouraged until conflicts between recreational fishermen and nearshore trawlers are resolved.

A small fleet of nearshore trawlers has operated out of Ocean City, Maryland for a number of years. Thus far, there have been no recent major problems between the Ocean City trawling fleet and the recreational fishing fleet. This is in part due to the relatively small size of the Ocean City trawlers, as well as the relatively small number of trawling vessels that operate.

Party boats, charter boats, and private recreational fishing boats in Delaware rely almost entirely on the seasonal abundance of nearshore fish species for business and/or recreation. The State of Delaware has legal jurisdiction over fishery resources only within three miles of the Delaware coastline. United States commercial fishing vessels of any type and size can, and do, legally fish for any nearshore fish species that are marketable. Nearshore fish species, including sea trout, croaker, rockfish, bluefish, summer flounder, porgies, etc., sometimes school in heavy concentrations as far as 20 miles from shore. On unobstructed bottom and in shoal waters, schools of these nearshore species are especially vulnerable to trawl netting and purse seining. During the summers of 1977 and 1978, several pairs of New Jersey trawlers were engaged in pair

trawling for sea trout near the mouth of Delaware Bay. Several incidents have already occurred between trawlers and charter fishing boats, and future confrontations are almost certain to occur.

It should be reemphasized that most of Delaware's important recreational finfish migrate through the nearshore FCZ. Development of a deep water port facility in Lewes might result in increased nearshore trawling pressure on the trout, flounder, croakers, etc. on which the recreational fishery depends.

RESOLVING CRITICAL PROBLEMS AND ISSUES

One problem that was identified as critical and in need of immediate attention in the Coastal Fishery Assistance Program contract for this past year is the boundary dispute between Delaware and New Jersey in the Delaware River and Bay. This problem has not been resolved, and it is outside the jurisdiction of the Division of Fish and Wildlife, DNREC, to resolve. However, it is being addressed by the Office of Management, Budget and Planning (OMBP) and should be resolved in the near future.

Many informal interviews were conducted with fishermen in gathering information on Delaware Coastal Fisheries issues, problems and opportunities. Although not critical, the most readily identifiable opportunity involving fisheries is the potential for a major deep water fishing port in Breakwater Harbor, Lewes, Delaware. Several meetings were attended that were sponsored by the Delmarva Advisory Council in gathering public comments on their "Delmarva Ocean Fishery Port Survey". Breakwater Harbor was designated as having very high potential for fisheries development. Subsequent meetings with Fisher Enterprises, Inc., the owner of the piers and property at Breakwater Harbor,and the Division of Economic Development were very productive in pursuing this opportunity. A brochure was designed with appropriate demographic and fisheries information to advertise the potential of the harbor facilities at Lewes. Governor du Pont, Sussex County officials, and the Mayor of Lewes have also endorsed the concept of a major fishing port in Breakwater Harbor.

Efforts should continue by fisheries personnel to provide advisory services to these officials in their promotion of Breakwater Harbor. Recreational, as well as commercial, fishing interests should be considered in providing facilities at the Breakwater Harbor.

Legislative needs were not discussed in any detail with legislators or fishermen during this program segment. Previous legislative contacts indicated a need for additional data to better ascertain if new legislation is required. These problems will, therefore, be more directly addressed in the next segment of the Coastal Fishery Assistance Program.

A meeting was attended in Fort Lauderdale, Florida which was sponsored by the National Coalition for Marine Conservation, Inc. and addressed the concept of a Marine Recreational Fishing License. Many participants were officials from other coastal states who agreed that the justification for such a recreational license is apparent, but the public is not yet in a position to accept such a license. Considerable opposition was expressed by many sport fishermen as to the use of revenues generated by such a license. Recreational fishermen apparently would be much more receptive of a recreational marine fishing license if assurances could be made that all funds derived from the sale of said licenses would be dedicated to marine recreational fisheries programs.

A meeting of the Technical Advisory Committee of the Atlantic States Marine Fisheries Commission was attended in Norfolk, Virginia to discuss the marine recreational fishing license and other interstate and state/federal fishing management proposals. It was evident from

the discussions that other coastal states are as much concerned with managing coastal inshore fisheries as Delaware. Future cooperation between states and the federal government must be pursued to better manage coastal fisheries without federal preemption of historical fishing interests within the various states.

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